

■ PROJECTS ■ THEORY ■ APPLICATIONS ■ CIRCUITS ■ TECHNOLOGY

NUTS
AND
VOLTS

NUTS AND VOLTS

www.nutsvolts.com
October 2014

EVERYTHING FOR ELECTRONICS

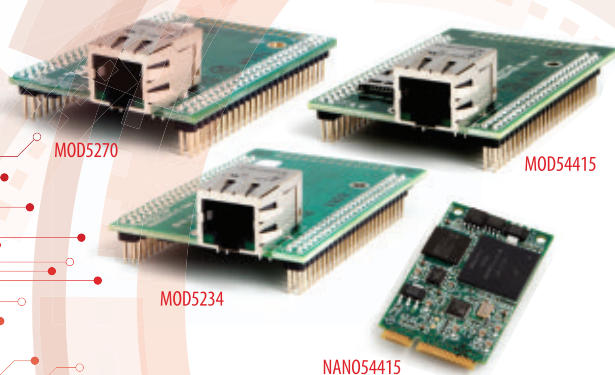
Repair & Refurb **Vintage Hi-Fi Gear**

*They don't
make 'em
like that
anymore!*

- ◆ **Electronics Q&A Is Back!**
*Current Measuring
Outdoor Audio Reception*
- ◆ **Hotrod Your Electric Guitar**
With Active Tone Controls

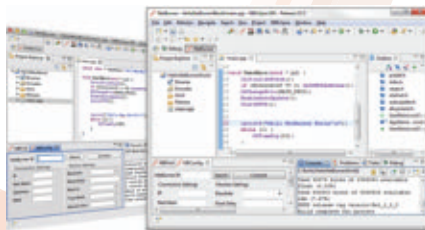


Ethernet Core Modules with High-Performance Connectivity Options



- **MOD5270**
147.5 MHz processor with 512KB Flash & 8MB RAM · 47 GPIO · 3 UARTs · I²C · SPI
- **MOD5234**
147.5 MHz processor with 2MB flash & 8MB RAM · 49 GPIO · 3 UARTs · I²C · SPI · CAN · eTPU (for I/O handling, serial communications, motor/timing/engine control applications)
- **MOD54415**
250 MHz processor with 32MB flash & 64MB RAM · 42 GPIO · 8 UARTs · 5 I²C · 3 SPI · 2 CAN · SSI · 8 ADC · 2 DAC · 8 PWM · 1-Wire® interface
- **NANO54415**
250 MHz processor with 8MB flash & 64MB RAM · 30 GPIO · 8 UARTs · 4 I²C · 3 SPI · 2 CAN · SSI · 6 ADC · 2 DAC · 8 PWM · 1-Wire® interface

Add Ethernet connectivity to an existing product, or use it as your product's core processor



The goal: Control, configure, or monitor a device using Ethernet

The method: Create and deploy applications from your Mac or Windows PC. Get hands-on familiarity with the NetBurner platform by studying, building, and modifying source code examples.

The result: Access device from the Internet or a local area network (LAN)

The NetBurner Ethernet Core Module is a device containing everything needed for design engineers to add network control and to monitor a company's communications assets. For a very low price point, this module solves the problem of network-enabling devices with 10/100 Ethernet, including those requiring digital, analog and serial control.

MOD5270-100IR.....\$69 (qty. 100)	NNDK-MOD5270LC-KIT .....\$99
MOD5234-100IR.....\$99 (qty. 100)	NNDK-MOD5234LC-KIT .....\$249
MOD54415-100IR.....\$89 (qty. 100)	NNDK-MOD54415LC-KIT .....\$129
NANO54415-200IR...\$69 (qty. 100)	NNDK-NANO54415-KIT.....\$99

NetBurner Development Kits are available to customize any aspect of operation including web pages, data filtering, or custom network applications. The kits include all the hardware and software you need to build your embedded application.

➤ **For additional information please visit**
<http://www.netburner.com/kits>



www.mikroe.com

Every embedded developer knows at least one of these words:
mikroC, mikroBasic, mikroPascal, Visual TFT, Visual GLCD, EasyPIC,
EasyPIC PRO, EasyPIC Fusion, EasyMx PRO, EasyAVR, Easy8051,
mikromedia, click, MINI, mikroBUS, mikroProg, Libstock...

How about you?

LEARN.DIGILENTINC.COM

Come visit the always-open classroom today!





Actobotics™

DREAM. DESIGN. BUILD. REPEAT.



NEW PRODUCTS

added weekly



THE SPOTLIGHT

A few of our favorite new products



HITEC
Brushless Servos

Metric Shafting

Servo Couplers

Connector Plates

Bevel Gears

Stepper Mounts

Set Screw Hubs

Motor Mounts

3 Wheel Robot Kit

Rubber Trim

Micro Gearmotors

Pillow Blocks

Channel Mount Servo Gearboxes

Tube Clamps

Sprockets & Chain

Servo Mounts

PLANETARY GEARMOTORS

6-12V HD Precision
\$39.99

3-12V Precision
\$27.99

PINION GEARS

Starting at \$5.99

CHANNEL SLIDER KIT

#637108
\$119.99

It's now easier than ever to put your videos in motion!

www.servocity.com | 620.221.0123 | sales@servocity.com

redesigned LINEAR SERVOS

Our newly redesigned Heavy Duty Linear Servo is here! Simply plug into just about any servo controller, wired or wireless. The advanced internal circuit board reads the PWM signal received from the servo controller and will precisely control the position of the linear servo!



#585428
\$10.99

Easily and quickly attach the linear servo to various contact points with our new mount!

Mounting points are 5/16"

To servo controller
To battery

The internal board is nearly bullet proof as it's protected against reverse polarity, over current and over temperature.

Aluminum stroke rod and outer tube

Extension shaft is 0.785" in diameter

Available in stroke lengths from 2" - 12"

offered in 3 different models



#HDLS-X-2-12V
25+ Pound Thrust
(2" per second)



#HDLS-X-50-12V
115+ Pound Thrust
(0.5" per second)



#HDLS-X-30-12V
180+ Pound Thrust
(0.3" per second)

New! MOBILE SITE

You asked, we listened. Now it's easy to browse and shop ServoCity on the go from your mobile device!





29 Hotrod Your Electric Guitar with Active Tone Controls

Retrofit your plain Jane guitar with the controls it deserves to give you a fuller range of bass, mid, and high end color.

■ By Thomas Henry

34 Build the Light Appliance

This IR remote controllable 32x32 RGB LED display does way more than just flash pretty lights.

■ By Craig A. Lindley



40 1963 Zenith MK2670 Stereo Repair

Vintage gear is very special, and has the advantage of simplicity so that even hobbyists can work on it. See how this particular stereo console got a facelift with a mix of old and new technology.

■ By J.W. Koebel

46 Prop Dropper 2

Check out this upgrade to a favorite project that will give you twice the scare power for Halloween.

■ By Chris Savage

51 Haunting with Video Projectors

A new trend in creating holiday displays is using digital decorations.

■ By Anthony Petrone

Go to the NV website to read Anthony's other fun project, the Ghost Phone.

Columns

10 TechKnowledgey 2014 Events, Advances, and News

Some of this month's topics include different types of refrigerator magnets, better satellite images, adding Wi-Fi to your Arduino, and wearable cameras, just to name a few.

14 Q&A Reader Questions Answered Here

Issues regarding measuring current with a clamp-on ammeter and outdoor reception of TV audio are discussed.

IT'S
BACK!!

18 The Spin Zone Adventures in Propeller Programming

Propeller Reanimator.

Bring your Halloween (or any holiday) props to life with the magic of circuits and code using the Propeller.

56 Near Space Approaching the Final Frontier

Wiring and Testing the BalloonSat Extreme Flight Computer.

More progress is made on our platform that will give advanced students practice integrating experiments into a single near space vehicle.

60 The Design Cycle Advanced Techniques for Design Engineers

Building a ZigBee HAN.

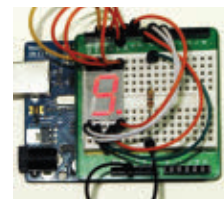
ZigBee has finally come home. This month, we will lay the groundwork for installing a ZigBee Home Automation Network. Our HAN can be accessed from the living room LAN or from anywhere in the world via the Internet.

67 Smiley's Workshop Programming • Hardware • Projects

The Arduino Classroom.

Arduino 101/Chapter 9: Keeping Time.

Take a much higher level look at computer time keeping, and learn to use some very novice-friendly applications available for the Arduino.



Departments

08 DEVELOPING PERSPECTIVES
Don't Get Stung
by a Wall Wart

08 READER FEEDBACK

26 NEW PRODUCTS

28 SHOWCASE

66 ELECTRO-NET
75 CLASSIFIEDS
76 TECH FORUM
78 NV WEBSTORE
81 AD INDEX

MIXED SIGNAL OSCILLOSCOPES

4 ANALOG + 16 DIGITAL CHANNELS

RAPIDLY DEBUG COMPLEX MIXED SIGNAL DESIGNS

- USB 3.0
- ULTRA DEEP MEMORY
- SEGMENTED MEMORY
- RAPID TRIGGERS



INCLUDES AUTOMATIC MEASUREMENTS, SPECTRUM ANALYZER, SDK, ADVANCED TRIGGERS, COLOR PERSISTENCE, SERIAL DECODING (CAN, LIN, RS232, I²C, I²S, FLEXRAY, SPI), MASKS, MATH CHANNELS, ALL AS STANDARD, WITH FREE UPDATES . 5 YEAR WARRANTY



	3204D MSO	3205D MSO	3206D MSO	3404D MSO	3405D MSO	3406D MSO
Channels	2 analog, 16 digital			4 analog, 16 digital		
Bandwidth	60 MHz	100 MHz	200 MHz	60 MHz	100 MHz	200 MHz
Buffer memory	128 MS	256 MS	512 MS	128 MS	256 MS	512 MS
Max. sampling rate	1 GS/s					
Signal generator	Function generator + Arbitrary waveform generator					
Digital inputs	100 MHz max. frequency, 500 MS/s max. sampling rate					

www.picotech.com/pco528



by Bryan Bergeron, Editor

DEVELOPING PERSPECTIVES

Don't Get Stung by a Wall Wart

Wall warts are used in place of internal AC-to-DC power supplies in most small devices — and for good reason. The powered unit can be more compact because of the obviously smaller parts count. There's also no need to make allowances for convection cooling of components in the powered unit. The downside, of course, is the need to control a never-ending, space-hungry herd of wall warts.

Until recently, a typical wall wart in my collection required at least two outlet spaces in my power strips: one for the prongs of the wall wart and at least one adjacent outlet partially obscured by the body of the wart. Given that new compact switching wall warts are so inexpensive, I recently upgraded my collection of conventional transformer and diode bridge warts to the switching variety. I've been happy with the upgrade — there's more space in the outlets and less clutter around my workbench.

Unfortunately, I learned the hard way that the latest generation of "regulated output" switching wall warts can have at least one major shortcoming: the regulated output can be up to 100% over the stated output voltage with no load. For example, a 9 VDC wart can output up to 18 VDC with no load. This isn't universal, but depends on the design of the switching supply.

I discovered this when I shipped out a dozen Arduino-

based animatronic systems for a research project. The systems left my shop — fully burned in — without a problem. However, the systems (which used 9 VDC switching wall warts for power) were DOA. I first thought of ESD, and modified the front end circuits of the animatronic systems to bleed off any electrostatic charges.

Luckily, before I sent the second batch of units off to the field, I ran across a thread in a forum about the no-load voltage levels in the same switching power supply warts I was using. It turned out that the users of my systems were plugging in the warts first, and then connecting the animatronic systems. This was guaranteed to generate a chip-killing spike if the no-load voltage was significantly greater than the load voltage. I solved the problem by ordering a dozen of the old-fashioned bulky wall warts with conventional non-switching circuitry. Problem solved — after quite a bit of expense repairing and reshipping the animatronic units.

Of course, not all switching wall warts suffer from this no-load voltage problem. The wall warts weren't something I found on eBay. They were standard items from my favorite parts supplier. Bottom line: Verify that the wall wart's output is what you expect before plugging it into that new system you're designing. **NV**

READER FEEDBACK

Count(er) Me In

Robert Reed's frequency counter project in the August issue is the best article I've seen yet in *N&V*. The counter could be adapted for use in many applications, and construction is well within the abilities of most hobbyists. His previous signal generator articles were great, but the counter is a home run.

Richard Duncan

Open Door for Apps

I really enjoyed Frank Muratore's article on "The Versatile Wireless Doorbell" (August 2014). He has some interesting applications. I'd like to add one more. My mother-in-law lives with us and requires 24/7 care. I attached the pushbutton to a lanyard around her

neck so she can summon help whenever she needs us. We use a battery powered receiver that is usually in the hallway, but we can take it outside if we're working in the yard.

Don Hicke

Diggin' the DIY Digits

Bryan Bergeron's editorial ("The DIY Differential") in the August 2014 issue was of interest to me because I've long had a thing for digital clocks. I built my first one in the mid-1970s from an article in the old amateur radio magazine, 73 using an analog 5314 clock chip and 4" Nixie-type displays from an old stock market display system. In the following years, I built and either gave away or sold more than 50 digital clocks using the Nixie

tubes with series-connected LEDs in a seven-segment setup and — when the prices came down — regular seven-segment LED displays.

In his editorial, Bergeron had been interested in a "large digit" LED clock. I'm curious as to what was meant by "large digit." Of all the LED display clocks I made, the ones that people liked the most had 4" digits for the hours and minutes, and 2" displays for the seconds. Many people said that when they'd glance at the clock to see the time, their eyes were naturally drawn to the larger digits, quickly giving them the current time. The smaller seconds digits were easy to see but couldn't be confused with the others.

What I'd like to see is an article about a six-digit clock which would drive many different display sizes. This would give the builder a wide choice of designs. Of course, 5" common-

Continued on page 59

NUTS AND VOLTS

EVERYTHING FOR ELECTRONICS

Published Monthly By

T & L Publications, Inc.

430 Princeland Ct.

Corona, CA 92879-1300

(951) 371-8497

FAX (951) 371-3052

Webstore orders only 1-800-783-4624

www.nutsvolts.com

Subscription Orders

Toll Free 1-877-525-2539

Outside US 1-818-487-4545

P.O. Box 15277

North Hollywood, CA 91615

FOUNDER

Jack Lemieux

PUBLISHER

Larry Lemieux

publisher@nutsvolts.com

ASSOCIATE PUBLISHER

Robin Lemieux

robin@nutsvolts.com

EDITOR

Bryan Bergeron

techedit-nutsvolts@yahoo.com

VP OF OPERATIONS

Vern Graner

vern@nutsvolts.com

ADVERTISING SALES

Garry Moore

adsales@nutsvolts.com

CONTRIBUTING EDITORS

Joe Pardue

Tim Brown

Jeff Eckert

J.W. Koebel

Craig Lindley

Anthony Petrone

Fred Eady

Jon McPhalen

Paul Verhage

Thomas Henry

Chris Savage

CIRCULATION DEPARTMENT

subscribe@nutsvolts.com

SHOW COORDINATOR

Audrey Lemieux

WEB CONTENT

Michael Kaudze

website@nutsvolts.com

WEBSTORE MARKETING

Brian Kirkpatrick

sales@nutsvolts.com

WEBSTORE MANAGER

Sean Lemieux

ADMINISTRATIVE STAFF

Debbie Stauffacher

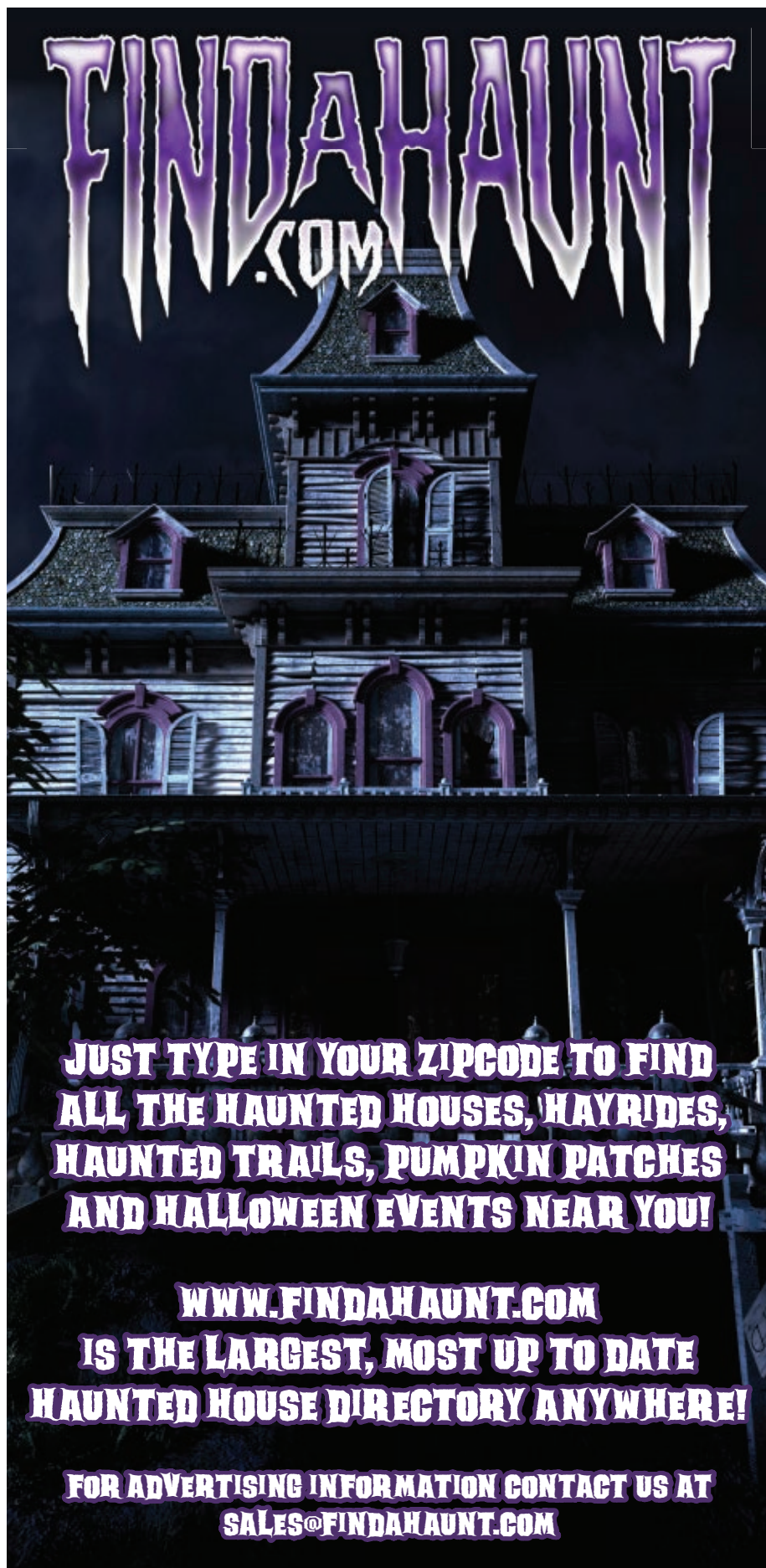
Re Gandara

Copyright © 2014 by T & L Publications, Inc.

All Rights Reserved

All advertising is subject to publisher's approval. We are not responsible for mistakes, misprints, or typographical errors. *Nuts & Volts Magazine* assumes no responsibility for the availability or condition of advertised items or for the honesty of the advertiser. The publisher makes no claims for the legality of any item advertised in *Nuts & Volts*. This is the sole responsibility of the advertiser. Advertisers and their agencies agree to indemnify and protect the publisher from any and all claims, action, or expense arising from advertising placed in *Nuts & Volts*. Please send all editorial correspondence, UPS, overnight mail, and artwork to: 430 Princeland Court, Corona, CA 92879.

Printed in the USA on SFI & FSC stock.



FIND A HAUNT

.COM

**JUST TYPE IN YOUR ZIPCODE TO FIND
ALL THE HAUNTED HOUSES, HAYRIDES,
HAUNTED TRAILS, PUMPKIN PATCHES
AND HALLOWEEN EVENTS NEAR YOU!**

WWW.FINDAHAUNT.COM
**IS THE LARGEST, MOST UP TO DATE
HAUNTED HOUSE DIRECTORY ANYWHERE!**

**FOR ADVERTISING INFORMATION CONTACT US AT
SALES@FINDAHAUNT.COM**

ADVANCED TECHNOLOGY



■ GE's prototype magnetic refrigerator put to good use chilling a beer.

Different Type of Refrigerator Magnets

The concept of magnetic refrigeration has been around for over a century, being based on the magnetocaloric effect first observed in 1881. It was then discovered that ferromagnetic materials heat up when exposed to a magnetic field and cool off when the field is removed. An early magnetocaloric refrigeration system built in 1933 produced a temperature of 0.25K (-272.9°C), and similar units have been used for years — largely for cryogenic applications in laboratories. Such systems basically operate by mechanically moving the ferromagnetic materials into and out of strong magnetic fields and using a fluid-based heat exchanger.

The main obstacles to producing commercially viable units have been the need to produce sufficiently powerful room-temperature permanent magnets and to come up with ferromagnetic compositions that produce a wide enough temperature change within a useful range. It appears the old compressor systems will begin to disappear within a few years, however, several companies have reported notable successes with magnetic system designs. These include General Electric (www.ge.com) which has a prototype that can reduce temperatures by 80°F while using 20 percent less electricity. The feat is accomplished by using a multi-stage process that involves 50 cooling stages to incrementally cool a water-based fluid.

Although the unit is presently about the size of a pushcart, GE believes that it will soon have systems that are small enough to fit inside a standard refrigerator or window air conditioner while producing 100°F of cooling with a 30 percent reduction in power consumption. There are, naturally, videos on YouTube. Just search "GE magnetic refrigeration" and you'll be offered videos ranging from two minutes to about half an hour. ▲

Live Long and Shop Lowe's

Like many advanced technologies, the first concept to emerge from Lowe's Innovation Labs (www.lowesinnovationlabs.com) was inspired by science fiction. Unlike many such concepts, however, you won't have to wait years to see it in action — at least if you live in or near Ontario. The Lowe's Holoroom — derived from and named after the Holodeck appearing in various incarnations of *Star Trek* — is already operational and ready to be installed in some Toronto stores later this year. According to Kyle Nel, executive director, "We know that for many homeowners, the struggle to visualize a completed home improvement project or to share that vision with others can stop a project in its tracks. The Holoroom is our solution, enabling consumers to visualize their project and share that vision with family and friends."

Before you get too excited, though, bear in mind that similarities between the Holoroom and the Holodeck are more metaphorical than literal. In the Lowe's version, you are not surrounded by realistic holographic images and authentic sounds. Rather, you use a tablet to choose furniture, appliances, plumbing, flooring, and other items, and arrange them inside a simulation of a room in your house. The augmented reality part of it kicks in when you walk around and aim the tablet at the chosen items which you can view from different distances and angles. You can make any changes you want and eventually come up with a completed design.

Finally, Lowe's will give you a printout to take home, and you can even share the model using a free app for iOS or Droid devices. It was further noted, "Additional product categories and rooms will be added to the Holoroom to help plan projects throughout the home over the next 12 to 18 months. Lowe's Innovation Labs will share updates on the Lowe's Holoroom as well as future initiatives on Twitter at twitter.com/loweslabs." ▲



■ Viewing a vanity installation inside the Lowe's Holoroom.

COMPUTERS and NETWORKING

Two-in-One Means Business

It appears that — having read reports of Microsoft losing \$1.2 billion on its Surface laptop-to-tablet convertible computers — Hewlett Packard (www.hp.com) management said, "Hey, we could do that, too." The result is the HP Pro x2 612 — it's similar, but geared primarily for enterprise applications. Like the Surface Pro 3, the HP 612 can be attached to a full-size keyboard (with its own embedded battery) or be used as a stand-alone tablet.

Unlike the Surface, it includes such business-oriented security features as HP BIOS, HP Client Security, HP Sure Start, HP Trusted Platform Module, a smart card reader, and an optional fingerprint reader. Powered by Intel Core i3/i5 processors, it also sports a 12.5 inch HD display, two USB 3.0 ports, and LTE broadband mobility via a Qualcomm 4G LTE modem.

Other features include dual high-def webcams and an optional battery-free Wacom pen, allowing users to write and draw graphic content with 1,024 levels of pressure sensitivity and palm rejection technology. HP claims 8+ hours of battery life when the

■ The Pro x2 612, HP's first commercial detachable PC.



612 is used as a tablet only, and 14+ hours with the tablet and keyboard combined. As of this writing, HP is still mum about the retail price. ▲

Better Satellite Images

Back in June, the US Department of Commerce decided to relax its restrictions on the distribution of high-res satellite imaging which previously required vendors to pixilate any views that exceeded 0.5 m resolution (i.e., in which features smaller than 50 cm are visible). Under the new rules, vendors will now be permitted to sell imagery at up to 0.25 m panchromatic (gray scale) and 1.0 m multispectral (color). Shortly

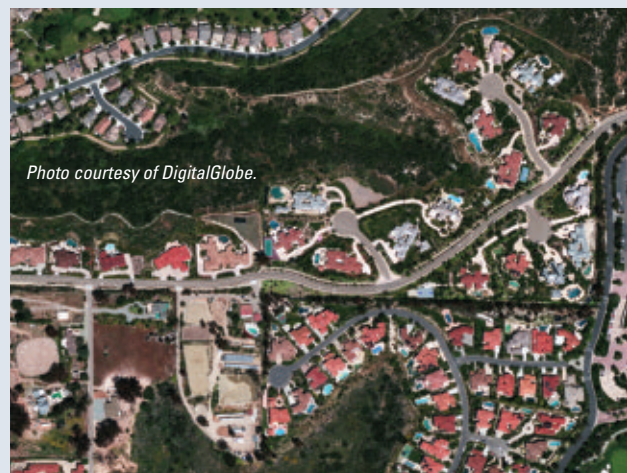


Photo courtesy of DigitalGlobe.

■ Satellite image of San Diego, CA at 0.5 m resolution.

thereafter, DigitalGlobe, Inc. (www.digitalglobe.com) — one of several satellite imaging companies — announced the upcoming launch of WorldView-3: the latest in the company's fleet of five Earth imaging satellites. According to DigitalGlobe, WorldView-3 "will set a new technological bar for commercial satellite imagery, offering customers the highest available resolution, revisit rate, capacity, and spectral diversity." The system is capable of providing 31 cm resolution which is a grade better than WorldView-2's 46 cm.

In practical terms, this means that you will be able to view and download black-and-white images in which things like mailboxes and manholes are easily discerned. Color imaging will be available down to 1.24 m resolution which allows a viewer to distinguish houses, individual cars, and so forth. How this will affect what you retrieve from an Internet search is hard to pin down at this point.

At present, DigitalGlobe's customers include US federal agencies including NASA and the DoD, and it provides services to Google Earth and Google Maps. Google recently shelled out half a billion dollars for Skybox Imaging — a start-up competitor that plans to have its own fleet of 24 satellites in orbit by 2018.

In any event, it's going to be much easier to spy on each other. ▲

COMPUTERS and NETWORKING Continued

Free Your PDFs

Somewhere along the line, Adobe decided to allow PDF file creators to impose a range of security restrictions that prevent others from opening, printing, copying, or otherwise modifying the file. Unfortunately, this means that a fair number of documents that you might download may be of little or no practical use to you. Never fear, however,

because it appears to be no big deal to remove the restrictions. One of the easiest ways is to log on at www.pdfunlock.com and upload your file. An unlocked version will be returned to you shortly. The service is free, but you are encouraged to make a small donation either directly or by clicking on a link to the National Multiple Sclerosis Society. ▲

CIRCUITS and DEVICES

Wi-Fi Your Arduino

If you are among the many people using Arduino microcontrollers to create gadgets (and there are an estimated quarter of a million of you), you know that the basic unit can be extended by plugging in various "shields" (i.e., boards that provide a variety of specialized functions). There are shields for MP3 playback, weather detection, motor drive, voice recognition, and pretty much anything else you could imagine. If your project needs to have Wi-Fi capabilities, you will, of course, need a Wi-Fi shield.

One of the latest is the xPico® device from Lantronix (www.lantronix.com) — a company that specializes in "smart Internet of Things solutions." The xPico supports simultaneous LAN client connectivity (802.11 b/g/n) and access point functionality, making it easier to connect to the Arduino via web-based tools and smartphone and tablet interactive apps. The company notes that the device "allows engineers,

designers, students, and hobbyists to quickly add smart Wi-Fi solutions to Arduino designs while offloading the burden of TCP/IP stack and networking applications to the included xPico Wi-Fi module." It is said to be easily configurable with little or no software development, and takes up only 24 mm x 16.5 mm of board space. The xPico retails for \$59, but a little online shopping can turn one up for as low as \$29.99. ▲



■ The Lantronix xPico shield adds Wi-Fi capabilities.

4K/25p Wearable Camera

If you are certain that your life is so interesting that it deserves to be recorded and broadcast to the humdrum outside world, Panasonic has just the thing for you. With the company's new HX-A500 point-of-view wearable

■ Panasonic's HX-A500, the world's first 4K/25p wearable camcorder.



camcorder attached to your head, you can record your every activity, even if you are slogging through a dust storm (it is dustproof), taking a shower to get rid of the dust (it is waterproof to 3 m for up to 30 min),

or operating in a less challenging environment. The quality of the video will be second to none, as the A500 shoots in 4K ultra-HD picture quality at 25 frames per second. The main body includes a 1.5 inch LCD monitor, and it is equipped with near-field communication capability so it is "just a swipe away from a Wi-Fi connection via your smartphone or tablet. Through the Panasonic Image App, you can then record and edit your video remotely, share your creations via social media, as well as broadcast them live using UStream."

The main operating unit weighs only 119 g (4.2 oz), and the camera just 31 g (1.1 oz). The unit features automatic leveling correction and image stabilization, and a slow motion function ups the speed to as much as 200 frames per second (with a corresponding reduction in picture resolution). The A500 will run you \$399.99 retail. ▲

INDUSTRY and the PROFESSION

Europe's First Ultracap Bus

All-electric cars have not exactly taken the market by storm, as they are plagued by many problems including weight, cost, long charge times, fire hazards, and a limited number of charge/discharge cycles. The problem is that batteries — in spite of many improvements — still store energy in a chemical reaction, the same as when Alessandro Volta invented them in

■ The Chariot E-bus now travels the streets of Sofia.



1800. This has led many prognosticators — including Tesla Motors' CEO Elon Musk — to speculate that ultracapacitors may someday supersede batteries in the automotive industry. The advantage is that ultracapacitors store energy in an electric field rather than an electrolyte, so they can be charged much more quickly and can handle hundreds of thousands more cycles than batteries. Conventional wisdom is that ultracap technology hasn't quite reached that level yet, so it is somewhat surprising to discover that earlier this year an ultracap-powered bus was put into service in Sofia, Bulgaria. (Bulgaria has Europe's highest atmospheric concentration of sulfur dioxide and carbon monoxide, so it was a logical place to start.)

The bus is the result of a partnership among Israeli-Bulgarian bus builder Chariot Motors (www.chariot-electricbus.com), China's Higer Bus Company, and ultracapacitor producer Shanghai Aowei Technology (www.aowei.com). "This is the first electric bus on European streets that does not require traditional battery charging and can cover its whole route on a single charge requiring just a few minutes. However, I'm confident that it won't be the last," said Zwicka Zimmerman, Chariot Motors chairman. Reportedly, Aowei's ultracapacitors have been pushing buses around the streets of Shanghai for more than seven years to the tune of more than 8,000,000 km. You have to wonder: Do they know something we don't? **NV**

2 Layers

\$3^{ea.}

PRINTED CIRCUIT BOARDS

- FULL DRC CHECK
- CAD/CAM REVIEW
- SOLDER MASK ON BOTH SIDES

Accutrace^{inc.}

www.PCB4u.com
(408) 748-9600

What is a Plasma Arc Speaker?



The Plasma Arc Speaker has a 3.5 MM audio input jack for use with MP3 players, computers, phones, etc. Uses a 12 VDC power supply, included.

PAS-01K \$89.95

Plasma is a hot ionized gas that is electrically conductive. The plasma arc speaker creates a plasma using a high voltage electrical discharge. When an audio signal is passed through the plasma it causes it to vibrate in sync with the audio signal. The plasma in turn vibrates the air around it to create sound.

Fascinating to watch!

IMAGES
SCIENTIFIC INSTRUMENTS

www.imagesco.com/kits/plasma-speaker.html

In this column, Tim answers questions about all aspects of electronics, including computer hardware, software, circuits, electronic theory, troubleshooting, and anything else of interest to the hobbyist. Feel free to participate with your questions, comments, or suggestions. **Send all questions and comments to: Q&A@nutsvolts.com**

• Current Measuring • Audio Reception

Post comments on this article at www.nutsvolts.com/index.php/?/magazine/article/october2014_QA.

Q&A is Back, Baby!

Many of you wrote to tell us how much you missed the Q&A section of *Nuts & Volts* and to ask when it might be back. Based on your feedback, we began the hunt for a talented new Q&A columnist and — as of this month — we've found one! So, we'd like to take a moment to introduce our new writer and your new Q&A host, Tim Brown!

Tim was introduced to the world of electronics at the tender age of eight through reading electronic hobbyist magazines. He learned to solder with a 250 watt soldering gun (not an easy task!) and spent quite a few hours of his youth daydreaming over the Heathkit™ catalog in the late '60s. He holds BS degrees in both Chemical and Mechanical Engineering, a PhD in Electrical Engineering, and a Professional Engineers license, as well.

During his professional career, he worked as an air quality environmental engineer and a chemical plant computer control engineer. He also spent 20+ years at a local community/technical college teaching electronics, automation/robotics, and engineering technology. We believe Tim will be a match for any technical questions you can throw his way. So, whether you're stuck on a schematic, pondering a project, or just curious about a circuit, please send your questions to Q&A@nutsvolts.com.

Measuring Current with Clamp-On Ammeter

Q I've used a VOM (Volt OhmMeter) for small circuits and automotive work, but recently I was asked to assist a friend with taking a current reading on a large motor at his shop. I have an "amp clamp" type clamp-on current measuring attachment for my meter, but I've never used it. It seems simple enough to use — I just set the meter to AC AMPS and plug in the amp-clamp part. I clamped it around the power cord leading to the motor, but it didn't show any current draw — which is weird since the motor was running when I did the test! I ended up using a Kill-o-Watt unit to get a reading, but was puzzled by the result (or should I say "lack" of results!) I got from my meter. Do you suppose the one I have is broken or was I just doing something wrong?

— Neil Shaw, North Carolina

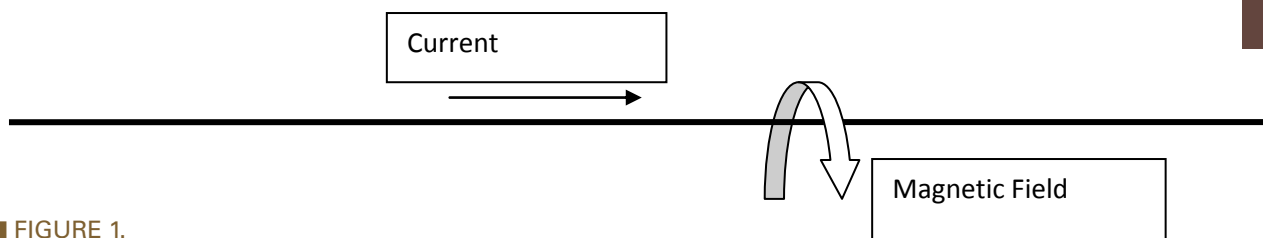
A In 1819, Danish scientist Oersted discovered that current flowing through a conductor (wire) produces a magnetic field that encircles the conductor. In 1820, French scientists Biot and Savart developed the Biot-Savart law which predicts the

magnitude and direction of this magnetic field. The magnitude of the magnetic field is a function of the magnitude of the electrical current in the wire, and the direction of the magnetic field is determined by the direction of current as shown in **Figure 1** for one conductor.

An electrical power cord is made up of two or more current-carrying conductors in close proximity. **Figure 2** shows the current and magnetic field directions for a two-conductor cable.

For the two-conductor power cable, the current in each wire is equal and flows in opposite directions, so the magnetic fields are equal in strength and opposite in direction. Therefore, the effect of these equal and opposite magnetic fields is to cancel each other. When an ammeter is clamped around both wires, there's no magnetic induction, thus a zero current reading on the ammeter. This is a common occurrence.

The way to measure the current using a clamp-on ammeter is to clamp only one wire at a time. This can be done in the motor's junction box. **CAUTION:** Turn off power when working with your body parts inside any electrical device. (1) Turn the power off the motor at the breaker and then remove the junction box cover. (2) Pull one power wire out (not a neutral on three-phase or



■ FIGURE 1.

ground on single phase) and clamp the ammeter around this wire. (3) Once your hands are clear of the wiring, turn on the breaker, power up the motor, and take your current readings. Typical readings for AC motors are: 115 volt single phase (most residences use single phase), 14 amps per horsepower (HP); and 230 volt single phase, seven amps per HP. If your friend happens to have three-phase motors (shown on the nameplate), the expected currents are: 230 - 2.5 amps/HP; and 460 - 1.25 amps/HP.

Good luck and work safely. Let me know your results.

Outdoor Reception of TV Audio

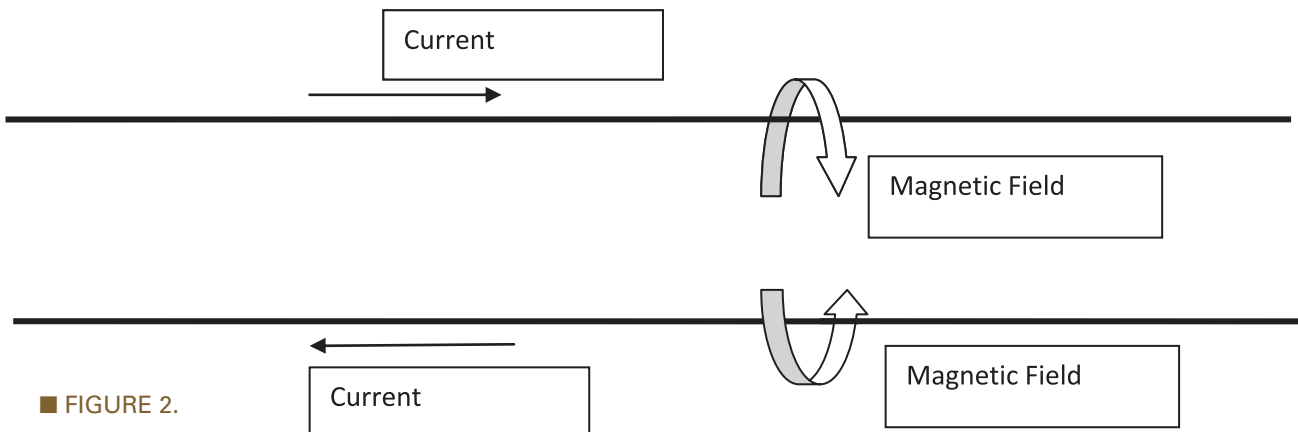
Q I have a next door neighbor who asked me to help him with a sound problem. His wife is an avid gardener and she likes to listen to the audio portion of TV shows while she works in their rather large back yard and shed. I suggested he get an FM transmitter and connect it to his TV so she would be able to listen by using an inexpensive FM radio headset while she works. He ordered the FM10C FM transmitter kit from Ramsey Electronics and I helped him put it together. This seemed to work very well and sounded great when we tested it in the house. However, when his wife tried it out, she said the audio would fade out and become just static when she was at the back edge of the yard or in their back shed. To fix this, I was thinking we might be able to boost the output from the FM transmitter, but a friend (ham radio operator) said this isn't legal to do — is this true? If so, can you think of some way I might be able to fix this issue and get clear signal all the way to the back of their yard?

— Carlos Simmons, San Marcos, TX

A Let's start with some radio theory. VHF FM (Very High Frequency, Frequency Modulated) signals are electromagnetic waves that propagate (move away) from a transmitting antenna at the speed of light. The FM broadcast band ranges from 88 MHz to 108 MHz (millions of cycles per second) which gives these waves a wavelength ranging from 2.8 meters (nine feet) to 3.4 meters (11 feet). At these VHF frequencies, the radio waves travel in straight lines. (Lower frequencies such as the AM band can bend around buildings and the Earth's surface somewhat). Radio signal strength decreases as a function of the square of the distance between the transmitter and receiver. In plain English, if the distance is doubled, the signal strength drops to one fourth. Or, for example, if the signal is 12 milliwatts (mw) at 12 feet, at 24 feet the signal will drop to 3 mw.

All radio waves are blocked by metals, so inside or in back of the shed is a problem unless you install multiple "repeater" transmitters which are frankly too expensive, and phasing and signal interference can result in many "dead" spots. Radio waves reflect off metal wires and buildings, which leads to signal fading. When the path lengths of two radio waves is a multiple of the wavelength, the two signals add and produce a stronger signal. On the other hand, when the path lengths vary by multiples of half wavelengths, the signals cancel each other so there is no reception. For path lengths in between, there are varying degrees of strengthening and cancelling (called interference of waves), so the signal fades as the receiver moves.

Your ham friend is correct, the Federal Communications Commission (FCC) Regulations limit unlicensed FM band transmitters to an effective radiated



■ FIGURE 2.

power (ERP) of one watt or less. These regulations are designed to keep different radio transmissions from interfering with other radio transmissions (like an “over-powered” CB radio being received on your TV or PA system). The FCC levies pretty stiff fines (\$10,000 to \$75,000) for violating these regulations which keeps most people honest.

Ramsey Electronics’ website says the FM10C transmitter has enough power to cover “a city” block and refers the user to the manual for antenna and range info. The first thing I would try is to check the transmitter frequency as outlined in their manual on page 14. Modern digital radios stay pretty well on the tuned frequency, whereas the analog tuning of the FM10C tends to drift due to component aging and temperature variations. If the transmitter and receiver are not tuned close to the same frequency, there will be an effective loss of the signal by the filtering action of the receiver.

Next, check the power supply voltage you are using. The Ramsey specs say the FM10C can operate with a range of voltages between 5 VDC to 10 VDC. A little secret: The higher the voltage you operate the transmitter, the higher the output power which means the longer the range of reception. If these remedies are not enough, look at antenna placement relative to the backyard (I assume that is where most of the time is spent based on your letter).

If the transmitter is hooked to the TV at the front of the house, there may be enough signal loss due to the house’s building materials to cause your problems. The ideal placement of the transmitter using the whip antenna that comes standard with the FM10C is on a deck in the middle of the back of the house (I realize audio cable runs may be a nightmare unless the TV is near a back window).

You could look at using an external FM band antenna installed in the backyard with as “short as possible” coaxial transmission line (coax in CB and ham lingo) between the transmitter and antenna (check with Ramsey to find the impedance of the antenna so you can match the coax characteristic impedance to the antenna’s impedance or there will be a LARGE signal loss). You should be able to hook the coax shield to the FM10C antenna ground and the center conductor of the coax to the FM10C’s signal (the other antenna connection). Make sure the antenna ground and signal connections are not shorted together or you will lose all signal power and possibly damage the FM10C’s power circuits.

The American Radio Relay League (ARRL) website at www.arrl.org is a good place to start looking for alternative antennas (which is too lengthy to cover here). A metal sheet placed about one antenna length behind the whip antenna would tend to increase the effective radiated power into the backyard (experiment with reflector spacing and antenna length/height/tilt for the best signal coverage).

In the “days of yore” with analog TV a solution, you would have been able to buy a receiver for the TV FM audio signal. With the advent of digital TV, I do not know of any portable audio receivers on the market for TV audio only.

My commendations go out to everyone today who builds electronics kits or devices. Kit or scratch building is a great way to learn electronics. In this day of “cheap manufactured” electronic entertainment and instant gratification, most people have forgotten the technology that gives them these fantastic devices (philosophy lesson for the month).

Good luck and let me know how things turn out. **NV**



PICBASIC PRO™ Compiler
BASIC compiler for Microchip PIC® microcontrollers

FREE
Student - ~~\$49.95~~
Silver Edition - ~~\$119.95~~
Gold Edition - ~~\$269.95~~

Download **FREE** trial now

Simple, Reliable, Affordable

WWW.PBP3.COM

PICBASIC and PICBASIC PRO are trademarks of Microchip Technology Inc. in the USA and other countries. PIC is a registered trademark of Microchip Technology Inc. in the USA and other countries.

25 YEARS Beta
LAYOUT
create:electronics

SPECIAL PRICE
to celebrate our anniversary!



\$575.00*

**Complete SMD Workstation:
Anniversary Reflow Kit V3**

* Shipping costs not included

save over \$50!**

** as compared with purchase of the individual components

Toll free: 888-977-7443

www.beta-eSTORE.com

eSTORE
Beta LAYOUT

More Parts. Less Waiting.



High Quality NTE and ECG Products

- Semiconductors
- Capacitors, resistors
- Heat shrink tubing, solder products
- Chemicals, much more
- No minimum order
- Cross-referencing for thousands of parts
- Prepaid ground shipping on orders over \$50

nte parts direct™
Quality is Always In-Stock

www.ntepartsdirect.com

SUPERIOR EMBEDDED SOLUTIONS

Technologic Systems

DESIGN YOUR SOLUTION TODAY
CALL 480-837-5200

www.embeddedARM.com

TS-7670 and TS-7680 Industrial Computers

- Up to 454 MHz ARM w/ 256 MB RAM
- 2 GB Flash Storage
- Industrial Temperature (-40 °C to 85 °C)
- DIO, CAN, Modbus, RS-485

TS-7670 Features:

- GPS and Cell Modem
- 1x Ethernet
- 2x microSD Card Sockets

TS-7680 Features:

- WiFi and Bluetooth
- 24 VAC Power Input
- 2x Ethernet

Pricing starts at

\$129
Qty 100

\$168
Qty 1

Low cost plastic enclosure available



TS-4900 High Performance Computer Module

- Up to 1 GHz Quad Core ARM CPU
- Up to 2 GB DDR3 RAM
- WiFi and Bluetooth
- 4 GB Flash and microSD
- Gigabit Ethernet
- SATA II and PCI-Express
- DIO, CAN, COM, I2C, I2S
- Industrial Temperature (-40 °C to 85 °C)
- Supports Linux & QNX
- Android & Windows Coming Soon

Pricing starts at
\$99
Qty 100
\$134
Qty 1



TS-8150 PC/104 development board available

TS-TPC-8390 touch panel computer available



We've never discontinued a product in 30 years



Embedded systems that are built to endure



Support every step of the way with open source vision



Unique embedded solutions add value for our customers

Propeller Reanimator

If you're a Halloween enthusiast like I am, this time of year gets pretty busy. Every year is an attempt to out-do the successes of previous years, and it rarely gets easier. Long gone are the days when a simple paper mache decoration was enough to impress the neighbors. Special effects in films and television have made us all very sophisticated and wanting more when it comes to entertainment — even the home-grown variety. Thankfully, those of us who are also microcontroller enthusiasts have a bit of an edge. No, our skills don't help with the sculpting, molding, casting, and painting of props — but after that part is done, we get to work magic with circuits and code.

As you know, I'm one of those lucky guys that gets to work in and around the entertainment industry. Not only do I get to work with some of the best artists and special effects engineers in the world, I get to learn from them — which really helps me this time of year! Oftentimes, Hollywood schedules are compressed on-the-fly — and they typically starts at ridiculous. This is why artists in the industry are constantly honing their skills and work very hard to develop a useful "bag of tricks." This is why I chose the Propeller.

One of my friends and clients in the business is Steve Wang. He's a heavy-hitter in the make-up and effects world (he writes and directs, too), and is one of the kindest, most generous people I know. Steve loves artists, and shares what he knows with those who are sincere about improving their skills. Steve can turn a blob of clay into anything. Give him some material and some paint, and he can make it look like *anything*. That's his gift (that he's ardently developed over the past 30+ years). What Steve doesn't know or do is electronics or embedded programming — so he calls on me to help him with special projects.

Like most genius artists, Steve is very fluid in his thinking. We have worked on projects for his clients where he's giving me suggestions nearly as quickly as I can type code. Thankfully, I have a large collection of objects and routines built up that I can call on. The power of the Propeller, my code base, and a lot of practice allow me to

be responsive to Steve's requests.

In the end, he is being responsive to his clients, and that's what really matters. In January, I was in his shop when a client came in to see a finished project. Tears were welling in her eyes because she was so moved by its splendor. This is why I like working with Steve and his team. Their hard work and devotion to the craft affects people at incredibly deep levels. To me, that's what entertainment is about.

We don't always have the time to do custom programming, but we still want a fantastic display for Halloween, right? What do we do? For projects that involve simple motion and lighting control, I developed a set of programs that work in conjunction with animation software. The first part (*streamer*) accepts servo and lighting data as a serial stream, and will convert that data to the appropriate outputs. The second program (*player*) can play the show data from an SD card after it has been exported by the animation program. The player also allows us to connect to an external audio device for synchronized sound. It's pretty easy, and it works — so well, in fact, that it's in use at two major theme parks in southern California, and one of them has adopted a variation of these programs for servo animatronic displays that are sent all around the world.

Using the *streamer* and *player* programs allows us to focus more on the art of the display, because doing that part well will always be challenging. For most of my *streamer/player* projects, I use the EFX-TEK HC-8+ controller combined with the AP-16+ audio player (this is what the amusement parks use, as well).

I'm part of EFX-TEK, so I have them at my disposal. I understand that you may not, so I'm going to present these projects as platform-agnostic as possible. As long as you have some sort of Propeller board, you'll be able to use the code and circuit options presented here with the *streamer* and *player* programs.

Stream Me Up, Scotty

The purpose of the *streamer* program is to control our prop hardware by interpreting data from an off-the-shelf animation program. My choice is Vixen. It's free, it's easy, and the creator (K.C. Oaks) is another one of those nice guys that really cares about the people who use his stuff. Every time I have asked him for a custom plug-in or add-on for Vixen, he has happily created it for me. We'll be using a couple of those here.

You may be asking, "Isn't Vixen a lighting controller?" Yes, it is. That said, the output from Vixen is a serial stream of numbers that we can interpret in any way we choose. The ease and flexibility of Vixen — along with its responsive

Post comments on this article and find any associated files and/or downloads at www.nutsvolts.com/index.php?/magazine/article/october2014_SpinZone.

development team — has made it a very popular choice for all kinds of interesting control projects.

(I use Vixen 2.1. There is a Vixen 3.x available, but the modules required for the *streamer* and *player* programs do not work with that version. I am waiting for Vixen 3.x to stabilize before transitioning to it.)

Okay, then, how does Vixen tell the streamer what to do? This happens through the use of an output plug-in which controls how Vixen formats the serial output. The protocol we're going to use was created by a long-time friend of *Nuts & Volts* readers, Scott Edwards. Way back in the day, Scott created a device called the MiniSSC (serial servo controller) that allowed one to control a bunch of servos using a simple serial message over a single wire. The MiniSSC takes care of the grunt work of refreshing the servos every 20 ms — something that was really tough for the BASIC Stamp 1, which was about the only game in town when the MiniSSC was created.

The MiniSSC protocol is simple. For each channel update, there is a three-byte packet:

<SYNC> <CHANNEL> <VALUE>

The sync byte is \$FF; this defines the start of a new channel packet. The next byte is the channel which can be from 0 to a theoretical maximum of 254. The final byte is the position value, 0 to 254. Of course, the MiniSSC would convert the position byte to an appropriate servo control pulse, and we will too. Every Propeller project has a serial programming connection; that's what we'll use to send data from Vixen to the *streamer* program.

The streamer will use **FullDuplexSerial** (the default serial object used in most Propeller programs) to handle the data coming from Vixen. For outputs, we can use servos, dimmers/digital outputs, or a combination of the two. Constants in the program take care of instantiating the servo and dimmer objects:

```
pub setup_objects
    serial.start(RX1, TX1, %0000, BAUD)

    if (SERVOS > 0)
        svos.startx2(SERVOS, SVO_BASE, {
            } SVO_MIN, SVO_MAX, {
            } @ServoStart, $FF)

    if (DIMMERS > 0)
        outs.start(DIMMERS, DIM_BASE)
```

Note that I'm referring to the second object as a dimmer. This can also be used for pure digital outputs like pneumatic valves and relays — we just have to ensure that control of such channels uses only 0 and 100% values on the Vixen timeline. I think the cleanest approach to parsing the MiniSSC data stream is to use a finite state machine. Here's the whole Magilla:

```
repeat
    case state
    0 :
        sync := serial.rxttime(3)
        if (sync == $FF)
            state := 1
            high(G_LED)
        else
            low(G_LED)

    1 :
        ch := serial.rxttime(1)
        if ((ch => FIRST) and (ch =< LAST))
            state := 2
        elseif (ch == $FF)
            state := 1
        else
            state := 0
            low(G_LED)

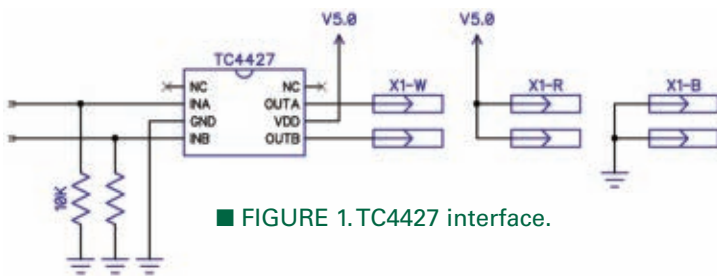
    2:
        level := serial.rxttime(1)
        if ((level => 0) and (level =< 254))
            update_channel(ch, level)
            state := 0
        elseif (level == $FF)
            state := 1
        else
            state := 0
            low(G_LED)
```

While in state 0, we will wait for a serial input of \$FF (sync byte). If this is received, we advance to state 1, and then turn on an LED (this is optional, of course, but helpful to see that data is being received). If there is a bad sync byte or timeout due to the space between frames, the LED will be extinguished. In state 1, we are waiting for a valid channel byte, defined by constants FIRST and LAST. If we get a good channel value, the state is advanced. Otherwise, we check for a new sync byte. If the channel number is out of range and not a new sync byte, the state machine is reset and the LED extinguished. Finally, in state 2, we wait for a valid channel level (0 to 254). If valid, we update the channel, otherwise we look for a new sync byte as in state 1. Easy, right? (You should be nodding and say, "Yes, Jon, it is!") With a valid packet in hand, we can update the channel. The constants for the program allow us to configure the streamer for servos and dimmer/digital objects. They also come into play when updating the outputs — we do that with **update_channel()**:

```
pub update_channel(ch, level)

    if (ch =< SVO_LAST)
        level := map(level, 0, 254, SVO_MIN, SVO_MAX)
        svos.set(ch, level, 0)
    else
        level := map(level, 0, 254, 0, 255)
        outs.set(ch-SERVOS, level)
```

In the program, there is a constant called **SERVOS** that sets up servo type outputs. The value of **SVO_LAST** is derived from **SERVOS**. If we're using four servos in our project, **SVO_LAST** will be 3. If we're only controlling



■ FIGURE 1. TC4427 interface.

Jon "JonnyMac" McPhalen
jon@jonmcphalen.com

Jack Mangano
Budget-friendly
servo controlled skull
www.audioservo
controller.com

EFX-TEK
Controllers and accessories
www.efx-tek.com

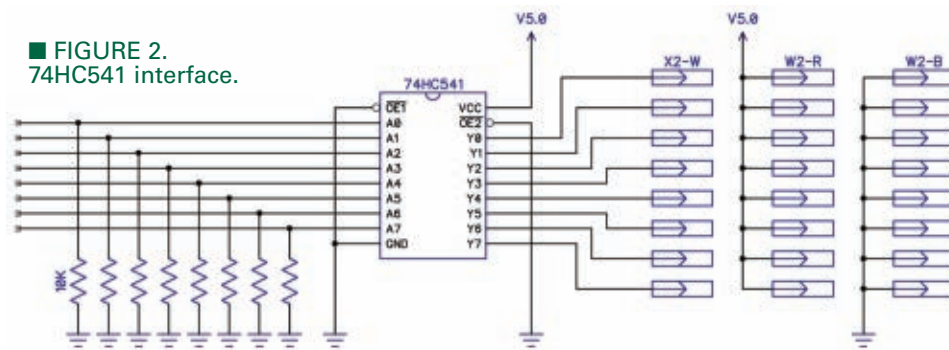
Parallax, Inc.
www.parallax.com
Propeller chips and
programming tools

dimmer/digital outputs, **SVO_LAST** will be -1.

In **update_channel()**, we check to see if the value passed in *ch* is in the servo range. If that is the case, the **map()** method will scale the 0 to 254 range to something more appropriate for servos, typically 600 to 2400 (microseconds). Channels that are not servos are considered dimmers or digital outputs. That's really all there is to the streamer: Accept serial input using the MiniSSC protocol, and then update outputs as required. It's important to note that the *streamer* program expects servo channels to be defined ahead of the dimmer channels. With a fixed number of outputs (as with the HC-8+), the number of servos limits the number of dimmer/digital outputs.

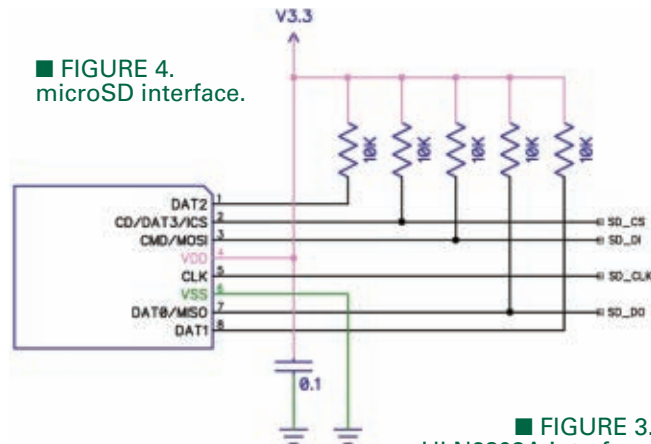
Circuit Circus

If you're going to run servos from the Propeller, I think it's best to boost its 3.3V output to 5V; this is what the servo expects, and the buffer will help suppress noise from the servo signal pin. If you have just a few servos, the TC4427 is an excellent choice. In fact, it's one of my favorite "accessories." This chip is actually a MOSFET driver that allows us to select the output voltage (Vdd pin). The stiff output is great over long wires. My friend, Lou, built a Propeller-powered focus and zoom controller for cameras



■ FIGURE 2.
74HC541 interface.

■ FIGURE 4.
microSD interface.



■ FIGURE 3.
ULN2803A interface.

that uses servos to turn the lens elements; he found that adding the TC4427 allowed for longer wires and better control.

Figure 1 shows the connections for the TC4427. For more servo outputs, we

can use a buffer like the 74HC541 — you'll find this on the Parallax QuickStart, and on later revisions of the HC-8+.

Figure 2 shows the connections for the 74HC541.

For LEDs, lamps, and pneumatic valves, the ULN2803A is a popular choice. The ULN2803A has built-in pull-downs, so we don't need to add them. Just remember that the ULN is an open-collector device which means it switches the ground side of the circuit. The other side — usually 12V — is the common side. Refer to **Figure 3**. Finally, if you're going to run files from the stand-alone player program, you'll need SD card access. The circuit in **Figure 4** is what I use in my custom designs. EFX-TEK has a microSD adapter for the HC-8+, and Parallax carries a microSD adapter that is breadboard-friendly. They also have boards like the Propeller Activity board and Propeller ASC+ that include a built-in microSD socket. The ASC+ (Arduino Shield Compatible) and an appropriate output shield is an easy what to build a prop

controller for Halloween. A word of caution for servo controlled props: Servos can demand far more current than we care to think about, especially with a heavy prop (like a talking skull) that is under load. For safety, budget at least 500 milliamps per servo from your 5V supply. For my skull project, I use a 5V/10A supply that I bought from Adafruit.

Getting Started with Vixen

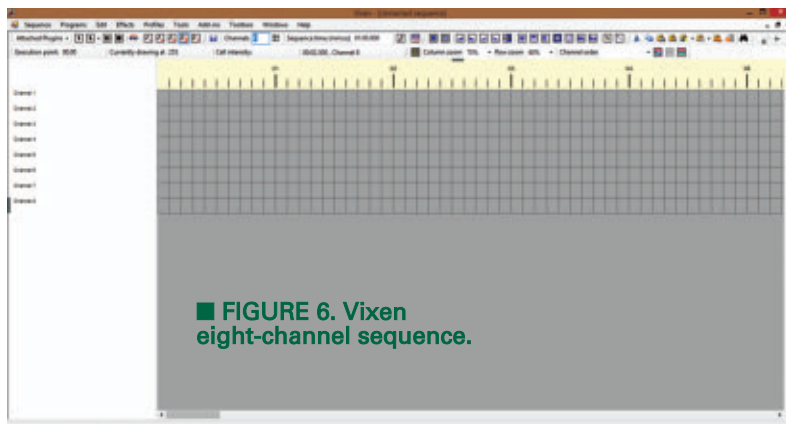
Vixen doesn't have a traditional installer program. It's just a ZIP file that you can unzip to any location you choose in your system. To make things easy for you, I've created a ZIP file of my setup — this ensures you have all the latest drivers. The file is pretty big, so I've put it in the Vixen section of the EFX-TEK forums. You can always get the latest release of drivers there. After unzipping the Vixen 2.1.x.x folder, find and double-click on **vixen.exe**.

After a short splash screen, you'll be presented with a blank window. Vixen uses an MDI interface, so you can have multiple projects open at once, though I don't recommend it. Let's say we want to create a project with four servos and four dimmer outputs.

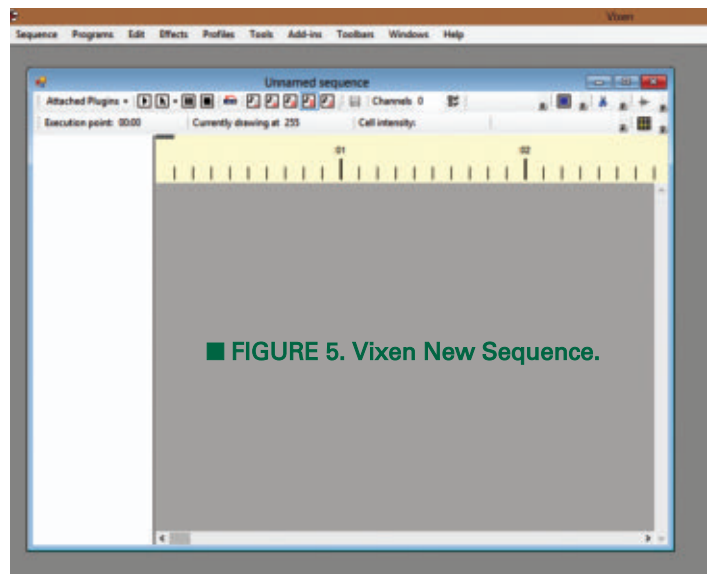
Click on **Sequence\New Event Sequence\Vixen Standard Sequence**. This will create an empty sequence with no channels (**Figure 5**). Set the number of channels to 8, and then click the maximize button to make things easier to work with (**Figure 6**). For servo animatronic projects, I use 20 ms event (frame) timing. To set up the sequence for the streamer, click on **Sequence\Settings**. In the dialog (**Figure 7**), we want to set the event period to 20 which corresponds to the update timing for standard servo drivers; this allows smooth updates from Vixen. Leave the channel level settings at 0 (minimum) and 255 (maximum).

When creating a new Vixen sequence, the channels get generic names; we can change that by right-clicking on a channel label. In the **Channel Properties** dialog (**Figure 8**), we can give the channel an appropriate name and even change the display color. The **Enabled** checkbox allows us to disable a channel without erasing the channel data. I find this useful for isolating a channel (e.g., the jaw movement of a talking prop).

If you're using servos in a prop, you may want to preset the value of those channels to the default position (usually centered, but could be something else). Right-click on the channel label again and select **All Events To...** in the context fly-out. To center servos, use 127 as the default value. Remember that we're using the MiniSSC protocol, so we have to convert the position value to something that fits into



■ FIGURE 6. Vixen eight-channel sequence.

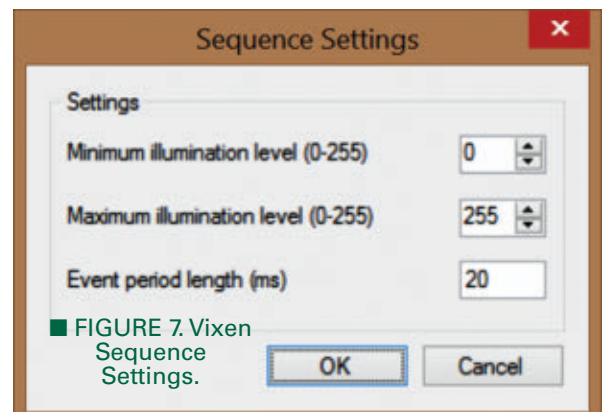


■ FIGURE 5. Vixen New Sequence.

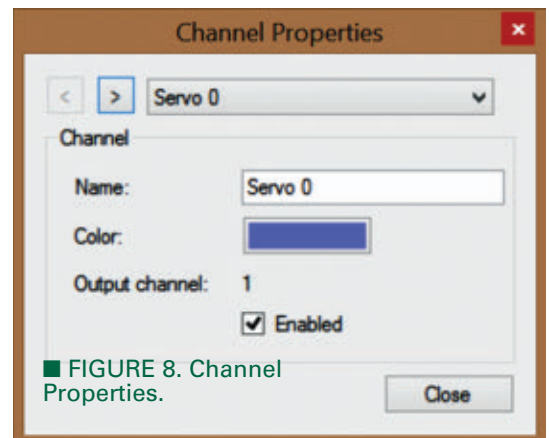
the 0 to 254 range. We can calculate the MiniSSC-compatible value with this formula:

$$\text{value} = (\text{position} - \text{servo_min}) / \text{servo_span} * 254$$

If we're using a 180 degree servo with a range of



■ FIGURE 7. Vixen Sequence Settings.



■ FIGURE 8. Channel Properties.

600 to 2400 microseconds, the span would be 1800. If the desired position is 1500 (center), we get

$$(1500 - 600) / 1800 * 254 = 127$$

The final bit of setup before we can start streaming data is to connect an output driver — in our case, the MiniSSC. Click on **Attached Plugins** (in the sequence window) to bring up the **Sequence Plugin Mapping** dialog. Scroll through the list on the left and select MiniSSC. Click the **Use** button to add it to the plug-ins list for the project (**Figure 9**). Select MiniSSC from the right-side list and then click on **Plugin Setup**. In the dialog, we need to set the COM port to match our Propeller board (yours will probably be different from mine). The baud rate is set to 57600. Set the Minimum value to 0 and the Maximum value to 254 (critical!). Finally, make sure that the **Scaling** checkbox is, in fact, checked as in **Figure 10**. Note that we're allowing the sequence to express values in the full range of 0 to 255, and then using the output plug-in to scale to the MiniSSC range. Quite some time ago when I first started exploring Vixen as a sequencer for servos, I used 100 and 200 as the output values to conform to a 90 degree servo range of 1,000 to 2,000 microseconds. My SX-based controller would multiply the Vixen value by 10 to produce the servo pulse. Using 0 to 255 on the timeline gives us the best resolution using byte values. With a blank sequence setup, use **Sequence\Save As** to save the template for your hardware. To create a project, open this template and use Save As again with the project name.

Now it's time to play — and I seriously mean that! After the streamer program has been downloaded to the Propeller, switch over to Vixen and give it a try. Please, I beg you, give yourself an hour or two (or 10!) of play time with Vixen before you start on a real project. It's quite simple, but has lots of options and you'll want to explore them. I tend to use the ramping options most. Simply drag-select events on a channel, then click on a ramping button. There are even options for partial ramps which work well with servo

movement. For projects that include audio, you can add it to the Vixen project using **Sequence\Audio**. Vixen accommodates a number of audio formats, though I think sticking with WAV or MP3 is the best way to go.

After connecting a piece of audio to the sequence, display it by clicking on the Audio Visualizer toolbar button (see the upper-right corner of **Figure 11**) — this button looks like a little audio waveform. Use the Column Zoom setting to make synchronizing events to the audio file easier.

Play It Again, Sam

In the Vixen **Add-ins** menu, you'll find a selection called **Raw Data Export** (**Figure 12**). This dialog writes the show data to a binary file (only the show data; audio is handled separately). When I worked with K.C. on this, we borrowed a page from the WAV file format: The binary export has a header, followed by the track data for all the frames exported. We'll cover the details later.

The player program is set up to wait for a trigger input. If you're programming a Halloween prop, a PIR sensor could be used. One of the amusement parks I work with uses big kid-friendly buttons on their displays. Once a start input is detected, we'll open the file and play it. For file access, I use **FSRW**; it has been around the longest and seems to have the best performance. In fact, at EFX-TEK, we use **FSRW** in the AP-16+ audio player to read WAV files from the SD card. **FSRW** works in my book; you can trust it.

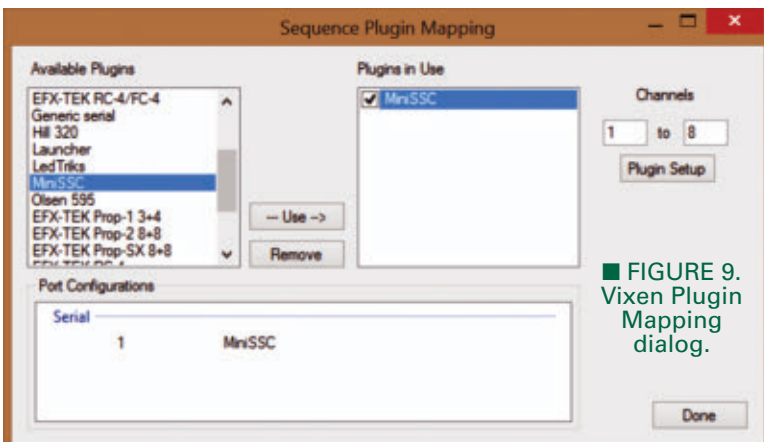
FSRW provides medium-level access, so I have several shell methods in my apps that use files:

```
pub mount_sd | check

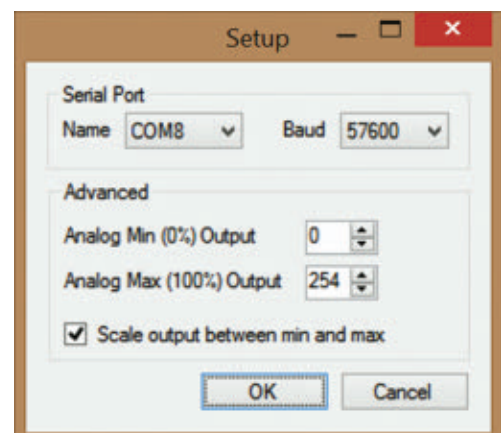
check := \sd.mount_explicit(SD_DO, SD_CLK,
SD_DI, SD_CS)

if (check ==> 0)
    mounted := true
else
    mounted := false

return mounted
```



■ FIGURE 9. Vixen Plugin Mapping dialog.



■ FIGURE 10. Vixen Mini-SSC setup.

The first method — **mount_sd** — gets us connected to the SD/uSD hardware. Note the use of the abort trap (\) in the code — this is important and **FSRW** makes nested calls. If an SD/uSD card is present, this method will set the global variable **mounted** to **true**:

```
pub open_file(p_zstr,
mode) | check

if (mounted)
  check := \sd.popen
  (p_zstr, mode)
  if (check == 0)
    if ((mode == "r") or (mode == "R"))
      \sd.seek(0)
      return true
    else
      return false
  else
    return false
```

This method opens a file in the desired mode (**Read**, **Write**, **Append**, or **Delete**). If successful, the method returns **true**. I found through experiments that initial file access seemed faster if I included a call to **FSRW's seek()** method for files opened in Read mode:

```
pub read_buf(p_buf, n) | check

check := \sd.pread(p_buf, n)
if (check == n)
  return true
else
  return false
```

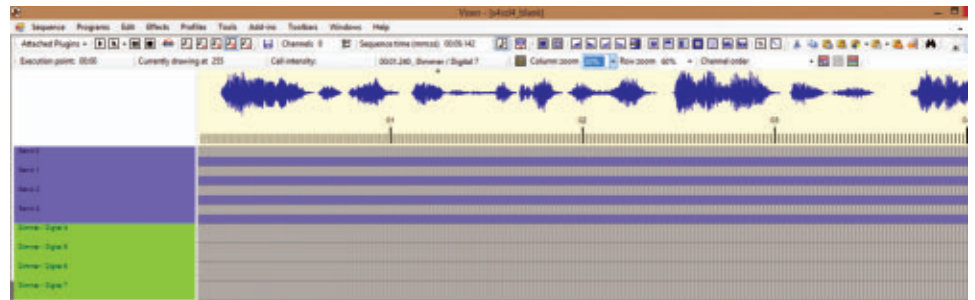
This is the method we'll use the most; it transfers a block of **n** bytes from the open file to the buffer pointed to **p_buf**. With that, let's get back to the file header.

The header consists of three 16-byte elements: channel count, event/frame timing (ms), and the total frame count. You may be wondering why we have a 16-bit value for channels when it's not possible to support that many. Let me explain. In the player program, we have these variables:

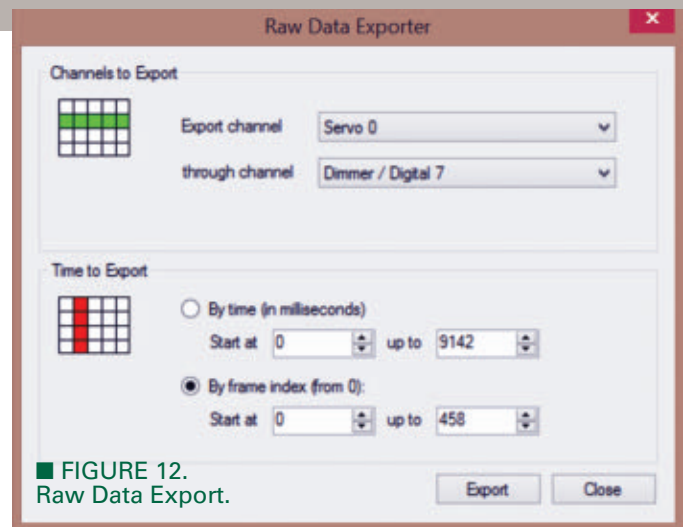
```
var
  word  filechannels
  word  eventms
  word  frames
```

Recall that variables of the same type will be laid into memory in the order they are declared. That said, it is critical to the operation of the player program that we do not change the order of these variables. When we want to play a file, we'll open using the **open_file()** method — something like this:

```
open_file(string("VIXEN01.BIN", "R"))
```



■ FIGURE 11. Vixen sequence with audio.



■ FIGURE 12. Raw Data Export.

This example is just to cover the syntax; again, we pass a pointer to a z-string and the mode as a letter. With the file open, we can transfer the header into our variables like this:

```
ifnot (read_buf(@filechannels, 6))
  close_file
  return
```

The first parameter of **read_buf()** is the location the bytes from the file will be transferred to; in this case, we are providing the address (@) of **filechannels**. The second parameter is the number of bytes to read. We must use six to cover three 16-bit variables. If there is a problem with the read (e.g., end-of-file indicator), we close the file and return to the caller.

This works because Vixen and the Propeller store values using *Little Endian* format (low byte, then high byte). By copying the first six bytes of the file to these variables, they are automatically set to the correct values. We use words for all three so that we can do this with a single call to **read_buf()** — better to give up one byte for a variable than several for multiple calls to import all header values. This would be required if we decided to make **channels** a byte — it would no longer lay into memory in the order we declared it.

At this point, playback of the file is very straightforward:

- Read a frame of channels into a buffer.
- Iterate through buffer and update outputs.
- Wait for the end of frame timing.

That's it. We'll run this loop the number of frames specified in the header. Let's have a look at the core playback code:

```
pub play_show(show) | frametix, t, ch, tix

byte[@ShowFile][5] := "0" + (show / 10)
byte[@ShowFile][6] := "0" + (show // 10)

ifnot (open_file(@ShowFile, "R"))
  close_file
  return

ifnot (read_buf(@filechannels, 6))
  close_file
  return

if (filechannels > CHANNELS)
  close_file
  return

frametix := MS_001 * eventms

t := cnt
repeat frames
  if (read_buf(@framebuf, filechannels))
    repeat ch from 0 to filechannels-1
      update_channel(ch, framebuf[ch])
    waitcnt(t += frametix)
    toggle(G_LED)

  else
    quit

close_file
low(G_LED)
```

The **play_show()** method expects a show number — 0 to 99 — though most projects will only use three or four. The first thing we do is update an embedded file name string:

```
ShowFile      byte      "vixen00.bin", 0
```

with the desired number. A series of check steps verifies that we can open the file, read the header, and that the file data is compatible with our hardware (channel count). Assuming all these pass, we convert event/frame timing (milliseconds) to system ticks, and then drop into the player loop. At the top of the loop, **read_buf()** is used to transfer a frame (of bytes) to an internal buffer. We iterate through the buffer using **update_channel()** to take care of the physical outputs. After the frame delay (using **waitcnt**), we toggle an LED before calling the next frame. This loop will continue until all frames are played. When done, we close the file and kill the LED before returning.

You're probably wondering, "What about audio?" That's easy, too. In my projects, I use the Propeller-powered AP-16+ audio player. It has a half-duplex serial

control port that allows easy integration into our projects. To keep things simple, I use the AP-16+'s standard naming convention for WAV files: SFXnn.WAV, where nn is a two-digit number.

The AP-16+ includes a serial command to play an SFXnn.WAV file by number. I encapsulate that command with this method in the player program:

```
pub apl6_sfx(addr, sfx, rpts)

  audio.str(string("!AP16"))
  audio.tx(addr)
  audio.str(string("PS"))
  audio.tx(sfx)
  audio.tx(rpts)
```

We can selectively enable audio in our project with the **USE_AUDIO** constant. Adding audio to the **play_show()** method is done like this:

```
if (USE_AUDIO == YES)
  apl6_sfx(%00, show, 1)
```

This is inserted immediately before the play loop. If you're using another audio player with your project, you'll need to modify the method that sends the appropriate serial command. Okay, I know what you're thinking now: "What about random playback of multiple files?" Excellent question, and the answer will help you create more interesting props and displays.

First things first. We will need to create a set of animation files for our prop — with audio, if that's a part of the project. Remember to keep the file names in sync with each other: VIXEN00.BIN corresponds to SFX00.WAV, etc.

A simple loop is used to inventory the show data files on the player's SD card. Note that this inventory method is limited to the number of bits in the *hasfiles* variable; I'm using a word, so I can inventory and manage up to 16 files (more than enough, I assure you):

```
hasfiles := $0000

repeat fn from 0 to 15
  byte[@ShowFile][5] := "0" + (fn / 10)
  byte[@ShowFile][6] := "0" + (fn // 10)
  if (open_file(@ShowFile, "r"))
    hasfiles |= (1 << fn)
  close_file

playlist := !hasfiles

lastfile := -1
```

The global variable *hasfiles* is used as the file inventory — each bit in the value (up to 16 bits for my projects) represents a file that is available on the SD/uSD card. We start by clearing that, then running a loop (0 to 15) that updates the embedded file name string, and then attempts to open the file. If the file is present and can be opened, a 1 is added to *hasfiles* in the appropriate position. Let's say, for example, that we have files VIXEN00.BIN through

VIXEN03.BIN (four files). This would result in a value of \$000F (%1111) in *hasfiles*.

Two more variables are used for random playback: *playlist* and *lastfile*. The former is used to keep track of the files played in the current cycle. This is initialized to the inverted value of *hasfiles*. A 1 in *playlist* means the file corresponding to that bit position is not available or has already played. In a 16-file project, a value of \$FFFF in *playlist* means that all available files have played and we can re-initialize for the next cycle.

There's one more detail that matters: the last file played. In my projects, I don't like to have the same file play back-to-back when I'm using random access. By checking the value of *lastfile*, we can ensure that we don't play the same file twice in a row:

```
pub random_start | btn, show

repeat
  prng.random
  btn := ttl_pin
  if (btn == 0)
    repeat
      show := prng.random & %1111
      if (show <> lastfile)
        ifnot ((1 << show) & playlist)
          quit

      play_show(show)
      lastfile := show
      playlist |= (1 << show)
      if (playlist == $FFFF)
        playlist := !hasfiles

    quit
  else
    pause(50)
```

If the player is set to random mode, the **random_start** method takes care of generating a random show number using the rules we've just covered. Using the HC-8+, a method called **ttl_pin** returns a value of 0 to 7 based on which TTL input pin is active. If none are active, that method returns -1. For random play, we only need to monitor one input (IN0).

When IN0 goes active, a random value is generated and then masked with %1111 to force it into the range of 0 to 15. If the new show number was not the last played, then a mask is created and tested against *playlist*. If the new show number was not the last played and hasn't been played in this cycle (i.e., not in *playlist* yet), we can break out of the inner loop and play the show.

After the show is finished, the values in *lastfile* and



■ FIGURE 13.
Talking skull.

playlist are updated. When the *playlist* is full (\$FFFF), it gets re-initialized using *hasfiles*.

Okay, there you have it. If you're using the HC-8+ and AP-16+ combination like I do, the *streamer* and *player* programs will run without modification. If you're rolling your own, you'll probably have to modify the pin constants and make changes to the input methods, as well as the control methods for your audio player. That should really be very easy work, however. Hit me up in the Parallax Propeller forum if you need an assist. The key now is to focus on the art of the project. In **Figure 13**, you can see the beast that I'm trying to tame (those of you that attended HauntX in Reno last May will have seen this dude on the EFX-TEK table running from an HC-8+ using the *streamer* program). It's a servo

controlled talking skull built by my friend, Jack Mangano. Jack's skull is something to consider if you want a very special greeter or talking Halloween attraction and you don't mind spending less than half of what a well-known commercial product goes for. Don't wait too long to get your order in with Jack, he's going to be very busy. And, yes, Jack uses the *streamer* and *player* programs with the HC-8+ and AP-16+ for his own and client projects. You can see a little demo video at www.youtube.com/watch?feature=player_detailpage&v=CUnMmFYDUMk.

I'll close with a few tips from my friend, Peter, who is an expert at talking animatronics (see his website www.socalhalloween.com for proof). If you're going to create a talking prop, make sure that the audio is clean (just the voice), and that you're only running the jaw movement until that is perfected. Once the jaw movement is ready, you can enhance the audio (I use Audacity for this) and add other movement tracks to the project.

To create the initial jaw movement, find the frame that is at the start of a syllable, and then open the mouth. Create a ramp on the other side that closes the mouth in about one second. Of course, most syllables are much shorter than this, so the jaw won't fully close before it is opened again. Remember that the lack of facial muscles and skin on many Halloween props removes information — we need to exaggerate the jaw movement a bit to make it seem natural to our eye.

Okay, then, have a safe, fun, and happy Halloween, and until next time, keep spinning and winning with the Propeller. **NV**

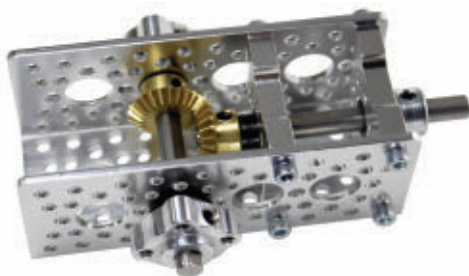
NEW PRODUCTS

■ HARDWARE
■ SOFTWARE
■ GADGETS
■ TOOLS

BEVEL GEARS

The new 32 pitch/24 tooth Actobotics bevel gears from ServoCity allow users to build right angle drives inside or outside of channel. These bevels work well for building differentials or any application where you need to transfer rotational motion 90 degrees.

Now offering both metric (4 mm - 6 mm) and SAE (1/4") bore diameters, these gears are appropriate for all kinds of applications. Simply slide the gear on the shaft and tighten the set screw. They are manufactured from hardened brass gear stock for extreme durability and strength. Prices start at \$5.99/each.



REDESIGNED LINEAR SERVOS

A redesigned heavy duty linear servo is also now available from ServoCity. While a linear servo may



appear similar to a linear actuator, it runs on a completely different signal. The linear servo can plug into just about any servo controller — wired or wireless. The advanced internal circuit board reads the PWM signal received from the servo controller and will precisely control the position of the linear servo. A PID algorithm is used in order to minimize settling time and overshoot.

The 24 kHz PWM output frequency creates very smooth movements without any PWM noise. The internal board is nearly bullet-proof as it's protected against reverse polarity, over-current, and over-temperature. There is a built-in circuit (BEC) that supplies power (5V, 500 mA) to your servo controller so that everything can be powered off a single power source. The aluminum construction ensures tremendous durability and reliability.

These linear servos are offered in stroke lengths from two inches up to 12 inches; the extension shaft is .785" in diameter. Mounting points are 5/16" diameter and are directly compatible with various ServoCity mounting brackets. Prices start at \$299.99/each.

For more information, contact:

ServoCity

Web: www.servocity.com

If you have a new product that you would like us to run in our New Products section, please email a short description (300-500 words) and a photo of your product to:

newproducts@nutsvolts.com



AP CIRCUITS
PCB Fabrication Since 1984

As low as...

\$9.95
each!

Two Boards
Two Layers
Two Masks
One Legend

Unmasked boards ship next day!

www.apcircuits.com



FREE EDA SOFTWARE

PCB prototype manufacturer, Beta LAYOUT LTD is now offering free EDA software for its PCB-POOL® customers. The free PCB and front panel design software is downloadable from their website.

Among the new and current features, the TARGET 3001! V17 PCB-POOL Edition includes:

Schematic Features with 3D Generator:

- Schematic capture (up to 100 schematic pages).
- Schematic, simulation, and layout with 3D view based on one central project file (real time data integration); no forward-back annotation.
- Simulation (SPICE, PSPICE compliant).
- 3D generator for component housing.

3D View:

- Live 3D view; fade in/out all elements individually.
- 3D data in STEP format, OBJ, and POVRay.

Component Features:

- Unique Componiverse function that allows uploading your own parts and downloading components of other users.
- 35K + components in a SQL database.
- Placement of components according to figures (cluster placement, alignment assistant).
- Integrated online placement calculation.
- Easy creation of individual components (package and symbol, simulation model, and 3D model) with endless component properties.
- Up to 256 variants of assembly within one project.
- Component Management System (CMS) with deep links to various distributors, providing datasheets accordingly.

Software Features:

- Import of netlists in OrCAD-Multiwire and Mentor format, TARGET-ASCII, and Gerber format.
- Creation of netlists in Protel, OrCAD, Calay, and Pads

The Convenient All-in-One Solution for Custom-Designed Front Panels & Enclosures



ONLY \$90.24
with custom
logo engraving

You design it
to your specifications using
our FREE CAD software,
Front Panel Designer

We machine it
and ship to you a
professionally finished product,
no minimum quantity required

- Cost effective prototypes and production runs with no setup charges
- Powder-coated and anodized finishes in various colors
- Select from aluminum, acrylic or provide your own material
- Standard lead time in 5 days or express manufacturing in 3 or 1 days

**FRONT PANEL
EXPRESS**

FrontPanelExpress.com
1(800)FPE-9060



EARN MORE MONEY Get your dream job!

**Be an FCC Licensed
Wireless Technician!**

**Make up to \$100,000 a year and
more with NO college degree**

**Get your "FCC Commercial License" with our
proven Home-Study Course!**

- No costly school. No classes to attend.
- Learn at home. Low cost!
- No experience needed!
- **MONEY BACK GUARANTEE:** You get your FCC License or money refunded!



**Move to the front of the employment line in Radio-TV,
Communications, Avionics, Radar, Maritime and more...
even start your own business!**

Call for FREE info kit: 800-877-8433 ext. 109

or, visit: **www.LicenseTraining.com**

COMMAND PRODUCTIONS • FCC License Training
Industrial Center, 480 Gate Five Rd., PO Box 3000, Sausalito, CA 94966-3000



Recycling & Remarketing High Technology

WEIRDSTUFF[®]

WAREHOUSE

Software, Computers, Electronics, Equipment, Doohickies

WE BUY/SELL EXCESS & OBSOLETE INVENTORIES

FREE COMPUTER AND ELECTRONIC RECYCLING

GIANT 10,000 SQ. FT. AS-IS SECTION

384 W. Caribbean Dr.
Sunnyvale, CA 94089
 Mon-Sat: 9:30-6:00 Sun: 11:00-5:00
 (408)743-5650 Store x324
WWW.WEIRDSTUFF.COM

DC PROPS

ANIMATRONICS
 STATIC PROPS
 MECHANISMS
 STARTLE EFFECTS
 CONTROLLERS
 PNEUMATIC PARTS

WWW.DCPROPS.COM

NATIONAL RF, INC.

Plug-in
Coil Forms

WxSat
Antenna

Misc
Elec
Odds
& Ends

Visit www.NationalRF.com for this
and other Radio Products!
 Office: 858-565-1319

600+ Items

B

Sound Activated Relays
 Motion Sensors
 Timers & Counters
 Voltage Regulators
 PWM Motor Controls
 Sound Kits Amplifier kits
 LED Chasers Custom Laser Cutting
 Educational Kits AM & FM Radio Kits
 Custom Circuit Designs
 5% Discount Code NV1014
www.bakatronics.com
 Serving Education, Industry & Hobbyists Since 2002
 All items shipped from our USA facilities

1. Apply solder. 2. Listen.

That's about how easy it is
with our complete,
step-by-step,
DIY amp kits.

Build one!

boxed

www.boxedkitamps.com

In the Nuts & Volts Webstore NOW!

NUTS AND VOLTS

NV BOOK SPECIALS

Programming the Raspberry Pi
Getting Started with Python

Raspberry Pi
Three Book
Combo

Raspberry Pi
User Guide

Raspberry Pi
Projects for the
EVIL GENIUS

Only \$48.95
 Plus
 FREE Priority Mail Shipping
 US Only

To order call 800 783-4624 or visit:
<http://store.nutsvolts.com>
 Limited time offer

NKC electronics

THE OFFICIAL ARDUINO STARTER KIT!

NKCElectronics.com/starterkit
 Includes the Arduino Project Book (170 pages)

Purchase Orders are accepted from Educational Institutions,
 US Government and Research Centers

format.

- Creation of BoMs in Protel, OrCAD, and Calay format.

Data Formats:

- Data formats for production on button-click: export to Gerber RS274-D; Gerber RS274-X; Excellon; Sieb&Meyer; DXF, Postscript; and TARGET-ASCII (referenced open ASCII interface).

DRC and ERC Checks:

- Design Rule Check (DRC) presented as a pre-PCB mfg utility
- Electrical Rule Checks (ERC) available with ease of use

Front Panel:

- Calculate and order the board at PCB POOL in TARGET 3001! V17, assembled or not.
- Design a front panel superimposed to your board layout.
- Calculate and order your front panel at PANEL POOL in TARGET 3001!.

For a more comprehensive list of features, access the PCB-POOL edition on their website, which is a full version of the software TARGET 3001! V17 specifically set up for PCB-POOL customers.

For more information, contact:

PCB-POOL

Web: www.pcb-pool.com

R/C AND SENSOR TRANSCEIVER MODULE SERIES

Linx Technologies announces the release of the first of many new RF modules in its next generation Hummingbird platform: the

Continued on page 75

HOTROD YOUR ELECTRIC GUITAR WITH ACTIVE TONE CONTROLS

By Thomas Henry

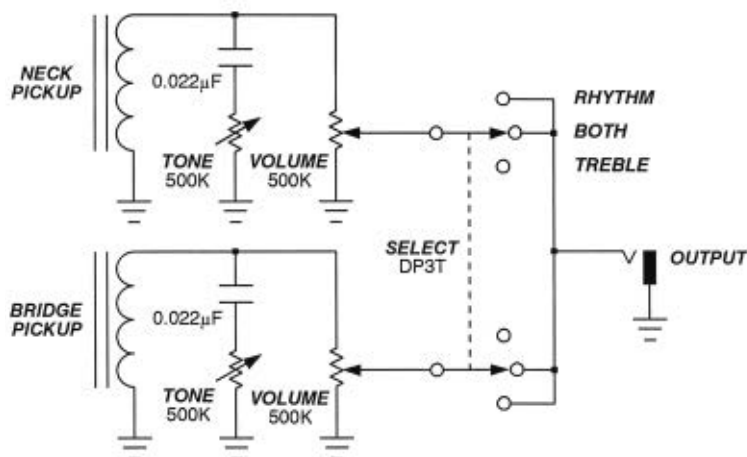
Post comments on this article and find any associated files and/or downloads at www.nutsvolts.com/index.php?/magazine/article/october2014_Henry.

In this day and age of highfalutin audio electronics, it is somewhat surprising that most electric guitars sport tone controls that weren't cutting edge even half a century ago. A new guitar still has a non-zero probability of sounding pretty "blah" no matter how good the pickups are. It may have a weak low end response, or perhaps the treble setting is dull. Maybe it doesn't offer much variation in tonal quality overall. This article describes a retrofit you can make that will give your guitar the controls it deserves. Even the most plain Jane instrument leaps alive with a full range of bass, mid, and high end color. Best of all, it does it quietly; noise, hum and hiss are simply not an issue thanks to several tricks explained here.



The Problem with Passive

To better understand the value of what's coming up, let's see how things are handled in a stock unit. The controls on a typical two-pickup electric guitar are often passive in nature (**Figure 1**). The capacitors shunt higher frequencies to ground, while their series potentiometers vary the amount of this action. Clearly, the most you could hope for with such a simple affair is the ability to gently roll off the treble response at about -6 dB/octave. The effect is so feeble that many guitarists simply leave the tone controls at full resistance and alter the sound on their amplifiers. Completing the circuit, two additional potentiometers directly parallel the pickups, providing control over the volume. In general, passive tone controls like this have a low input impedance which can load down the pickups appreciably. This typically results in an attenuation of the higher frequencies, yielding a sound lacking sparkle or brilliance. To lessen this effect, 500K potentiometers (a fairly high value indeed) are used throughout. This then raises the output impedance of the circuit, giving less than optimal results when



■ **FIGURE 1.** Passive controls on a typical electric guitar.

driving the audio cable and amplifier. Actually, it all gets quite complex with other matters such as signal-to-noise figures, RF interference, and even the capacitance of the connecting audio cable complicating the issue. In any event, the result is usually a poorer tonal response than we'd hope for even with the controls open full tilt. So, we have several problems to overcome. Passive circuitry like this: tends to load the pickups down; has a high output impedance less than ideal for driving the amp; and offers no more than a -6 dB/octave cut, which isn't very inspiring.

Enter the Active Controls

Pretty clearly, the solution lies in internal active electronics. Commercial affairs didn't appeal to me because of the price, and a search of previous DIY projects failed to turn up circuits with the features I desired. So, I decided to go it alone by starting from scratch.

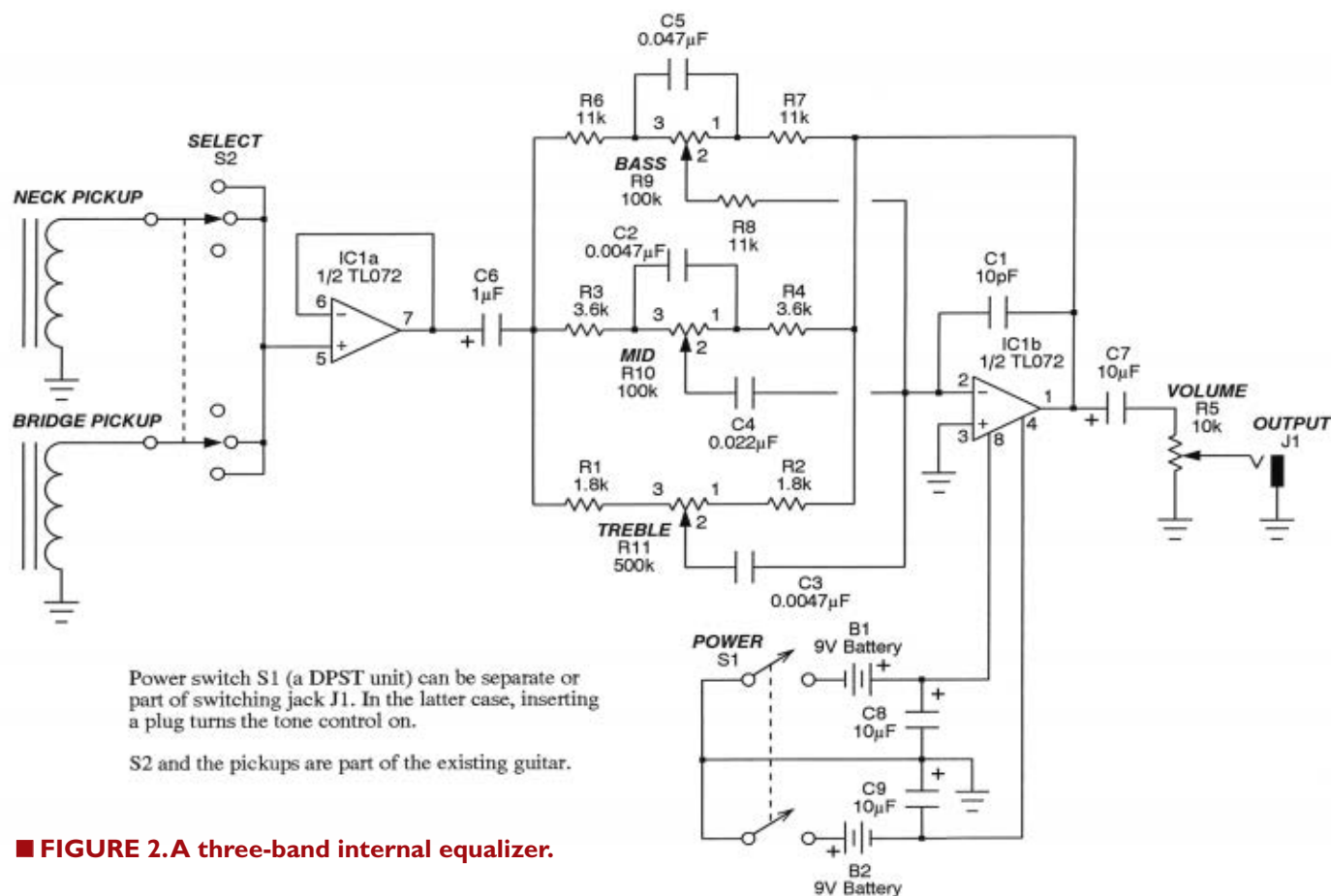
What resulted is a tiny bit of circuitry fitting completely inside the electric guitar. It offers a whopping 15 dB of both cut or boost in three separate bands. Many people think of emphasizing a frequency range to be the touchstone, but actually the deep reductions possible with this unit are just as important. It is often the case that pickups on their own emphasize the midrange which (to my ears) yields a muddy

result. With this circuit, it is possible to flatten out the response giving a fuller sound at the two extremes. Of course, with multiple bands, it's possible to create all sorts of tonal mixtures right from your fingertips.

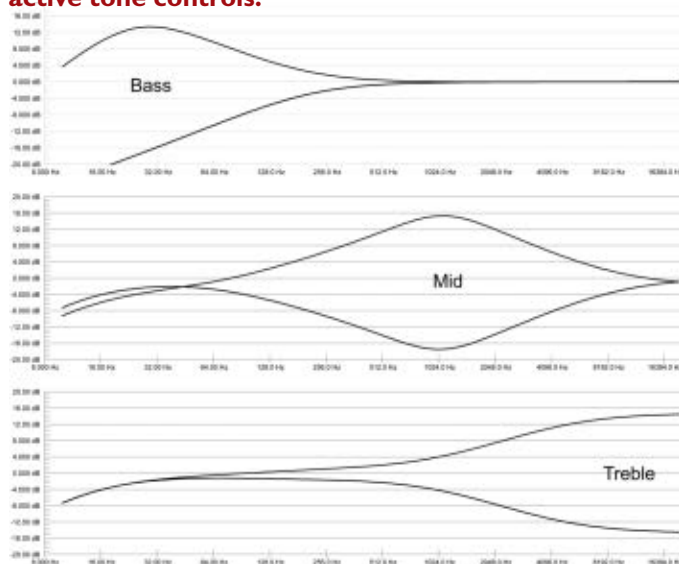
The benefits don't stop there, however. Even if you ran this device flat (the bass, midrange, and treble controls set to their midpoints), your guitar would still sound more alive. The reason for this is that the pickups are now fully buffered. Loading and attenuation of the highs are nothing more than memories. Moreover, the output has a very low impedance, allowing you to drive any amplifier or effects device without losing crispness. Of course, this is also a preamplifier, which can boost the signal and may prove useful for overdrive applications, among other things. If this all sounds appealing, then let's get into the circuit details.

A Look at the Circuit

Figure 2 shows the schematic for the active tone controls. We'll move the pickup switch to the input of the rig now, which allows us to buffer any combination selected; compare the location of the switch in **Figures 1** and **2** to see this. The wiring of your guitar may change, but you shouldn't have to drill any new holes or leave old ones unused. (Many electric guitars have four potentiometer



■ **FIGURE 3. Response curves for the active tone controls.**



holes with an additional hole for the pickup selector switch).

The pickups are buffered by IC1a. Recall that the non-inverting input of an op-amp sports an extremely high input impedance. So, now instead of a 500K pot bridging the pickups as in **Figure 1**, we have something on the order of many megohms doing so. In effect, we have completely unloaded the pickups, permitting every natural frequency component to pass with ease. The buffered pickups are then capacitively coupled by C6 to the remainder of the circuit which implements a three-band EQ. The basic topology for this comes from a manufacturer's datasheet, *Audio Handbook* (Santa Clara: National Semiconductor Corporation, 1977), pp. 2-44 through 2-49, edited by Dennis Bohn. The frequency-determining components cluster around potentiometers R9, R10, and R11 which are the bass, midrange, and treble controls, respectively.

You'll note that the entire three potentiometer structure is in the feedback loop of IC1b. As we'll see in just a moment, it isn't necessary to understand the mathematics of this circuit in order to customize it. If you're interested, the datasheet mentioned gives the details of the derivation. By the way, the only purpose of capacitor C1 is to suppress spurious supersonic oscillations or RF interference. Finally, the output is AC coupled by C7 to volume control R5. By using capacitive coupling here, any small DC offsets are blocked from hitching a ride to the volume pot, which typically



■ **FIGURE 4. Shielding cavities with copper foil tape.**

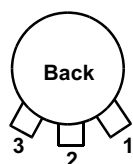
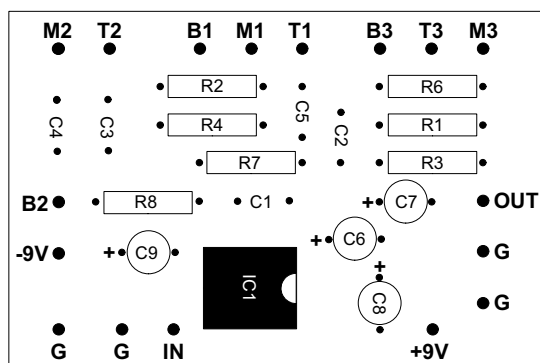
results in scratchy noise as the control is rotated. I suppose it would be possible to run this affair on a single battery with some additional components, but I decided to go with two for several reasons: There's more headroom, even with all the boost available; clipping is never an issue; most op-amps perform better on a dual supply; a single supply requires additional components; and in any event, the two batteries last darn near forever since this is a low current affair.

Personalizing the Frequency Response

Let's get serious about investigating what you can expect from the tone controls. When I first set about this project, I spent many hours pondering exactly how I wanted my axe to perform. I decided that my goal was to attain a full-bodied sound with decent control over the bass, midrange, and treble, but not really get into wild special effects. I next ran repeated SPICE simulations to see how the controls would interact. Don't kid yourself. A three-band

circuit like this is going to lead to some incredibly messy and difficult equations on paper. The only reasonable approach nowadays is to model the behavior on the computer before committing. The values shown in the schematic of **Figure 2** are those from the original datasheet mentioned earlier, and they worked very nicely on my Gibson Les Paul Standard. On the other hand, I ended up tweaking various values when I built another version for my less expensive Epiphone guitar. When the three controls are centered, the response is essentially flat, as the computer simulation software will confirm (more on that in a moment).

Figure 3 shows what happens when you cut or boost the bass,

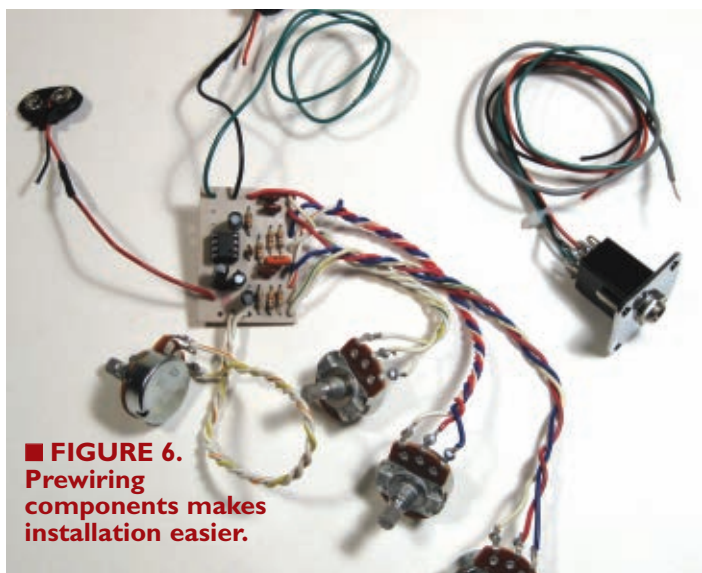


The pot connections are labeled B, M and T for bass, mid and treble. The lug numbers are shown in the illustration to the left. For example, T1 connects to the right lug of the treble pot (R11) as seen from the back.

There are several ground pads (G) for your convenience.

The meanings of IN, OUT, +9V and -9V should be obvious.

■ **FIGURE 5. Parts placement guide and wiring details.**



■ **FIGURE 6.**
Prewiring
components makes
installation easier.

midrange, and treble. The vertical axes are measured in decibels, while the horizontal axes are laid out in octaves (each tick mark represents a doubling of frequency). As you can tell from the curves, this circuit offers more than you'd ever find in the passive controls of the typical electric guitar.

I also ran checks on how the three bands work together. I essentially tried every combination of boost or cut for each of the bands in pairs, and then in trios. Don't feel obligated to stick with my choices. Altering the response is as simple as changing the capacitor or resistor values around any of R9, R10, and R11. In any event, the basic topology (and hence the printed circuit board; PCB) remains unchanged, so you can go with any option you want. Now's your chance to personalize things! Do what I did — run the simulation software to arrive at values you like best. "A Touch of Spice," by Peter J. Stonard, *Nuts & Volts*, Dec 2008, pp. 50-56 will get you started, and even tells you where you can locate the software for free.

Getting Ready to Build

So, we now understand the basics of the circuit and presumably you've arrived at some component values to give you the response you're after. Electronically, this is an easy project to construct but putting it inside your guitar takes patience, care, and attention to detail. I'll explain the steps I took (which worked out remarkably well, I must say), but you're on your own here. You'll have to decide if you have what it takes to work neatly on an instrument you love. That said, here's what I did. The first step was

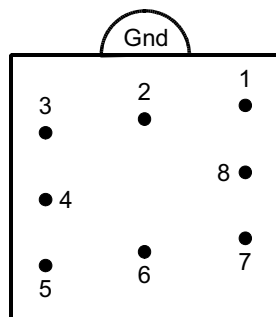
to gut the guitar of the existing passive circuitry. As mentioned earlier, I've actually done this on two guitars now. To make the discussion specific here, I'll show you how it went on my road-worn but trusty Gibson guitar. Similar steps should apply to other instruments.

I began by opening up the three cavities housing the existing controls, the pickup selector switch, and the output jack. I carefully desoldered the pots, switch, and jack. The first step was to rewire the switch as indicated in back as in **Figure 2**. I made it a point to label the various wires running throughout the channels in the body of the guitar as I went along. The pots were set aside altogether since I opted to start over again with four new and better quality ones. (I did save them in case I ever wanted to revert to stock again.) The main thing here is to clean out the cavities completely, which will probably entail vacuuming the sawdust left by the manufacturer (I'm not kidding). Incidentally, now's the time to work out the replacement potentiometer business. Both Jameco and Mouser had the knurled shaft pots I needed for my two guitars, but you might have to scout around depending on your make. The main thing here is that I only took advantage of existing holes; once complete, there was no change to the external appearance of either instrument.

Now comes an aspect that's just as much a part of the success of this project as anything. Most guitars are simply wood and little more. Thus, the cavities housing the controls, switch, and jack are not shielded and open to attacks from 60 cycle hum. To save money, guitar makers get around this by running a wire from the metal bridge of the guitar to ground. The general idea is that when your body is in contact with ground through the strings and bridge, it acts as a shield in some strange sort of way. (Don't

ask me how it works, but it does). I don't know about you, but I don't really like being a conductor. If hot and neutral to the AC supply of the guitar amplifier and the PA system, say, are flipped, then you're really opening yourself up to a shock hazard. (You can probably tell I've spent some 20 years of my life playing dilapidated ballrooms with substandard wiring.)

My solution was to completely remove the connection from the bridge to ground, and simply shield all inner surfaces with copper foil tape. So, locate the single wire coming from the bridge to the main control cavity, desolder it from ground, wrap it up, cover it with electrician's tape, and poke it in an out-of-the-way spot. Don't just clip it off in case you later discover you really do need it to avoid hum problems. Next, using copper foil tape, completely cover the inner surfaces of the three cavities.



This is the pinout for a typical DPDT switching jack, but check yours first with a multimeter. Only one throw is needed here, so lugs 3 and 7 can be ignored, as can lug 8 which is the ring for a stereo signal.

Switch 1: 1 & 2
Switch 2: 5 & 6
Ground: Gnd lug at top
Tip: 4

■ **FIGURE 7.** A switching jack turns the unit on and off.

The tape is conductive on both the front and back sides, so you can overlap things bit by bit with smaller pieces to blanket even the most curvy area. **Figure 4** shows this in progress for the control cavity. When you're done, screw a solder lug into the wood so that it contacts the foil, and connect a single ground wire (from the output jack, say) to ensure each cavity is grounded.

Don't forget to apply foil to the back side of the covers; you can also see this in **Figure 4**. Once the seals are in place, all of the pots, the switch, and jack are completely enclosed just as if you had built them within a metal box. I'm amazed at how well this all worked. I have no hum whatsoever, and best of all, will never have to worry about sparks from the lips again. You can seal up the switch cavity now, but leave the control cavity open since we still have to implant the electronics.

Bring On the Circuitry

Now comes the easy part. Building the active tone control is quite straightforward. Since this has to fit inside the control area along with four pots and two batteries, space is at a premium. For that reason, a PCB is the only way to go. Artwork is available at the article link, while **Figure 5** here shows the parts placement guide. Be sure to check all electrolytic capacitor polarities carefully, as well as the orientation of IC1. The potentiometer wiring scheme is depicted there, as well. Notice too that the pot lugs are numbered on the schematic which helps keep you from wiring them backwards. Speaking of which, it makes sense to prewire the potentiometers as much as possible since the control cavity is fairly tight to be sticking a soldering iron into. **Figure 6** shows the completed rig just about ready to go inside the guitar.

I haven't said anything about the power switching yet. I think the neatest approach is to use a switching jack. This is a 1/4" phone jack which also includes an independent DPDT switch. When a plug is inserted, the switch part does its thing closing the connections to the two batteries, while the audio portion is free to pass the signal as usual. **Figure 7** gives the details for the jack I used, but you should test yours with a multimeter in resistance mode to make certain you understand the pin configuration.

Figure 8 shows the completed implementation just before sealing up the back. That's the PCB on the left, components facing downward, and with a piece of black foam covering the foil side. Next to it is a pair of batteries, wrapped in a piece of plastic sheeting and taped together as a block. The remainder of the cavity is plugged with pieces of foam rubber to keep things from rattling about. All in all, it is a nice, tidy, and snug fit. I really took pains planning my moves (you should too), and didn't try to do too much at once or while tired. Anyway, once the cover plates were back in place, it was impossible to tell outwardly that this guitar had become bionic in the meanwhile.

■ **FIGURE 8.**
The job is done and ready to be sealed up.



One final detail. The active tone controls give a flat response when in their central positions. This means that you've got to be able to find that setting easily. A neat solution is to use some nickel-plated knob indicators which are secured in place over the pot bushings by the pot nuts. The pointers remain static while the numbering on the knobs register against them as the controls are turned. In my setup, when the bass, midrange, and treble controls are aiming at 5, then I know I'm at my flat reference point. Moreover, when the volume control is at 5 as well, I'm at the correct "normal" level for my system. The **Parts List** describes where you can locate the knob indicators and other items out of the ordinary. So, if Dullsville is the name of your guitar, consider resuscitating it with active tone controls. It takes care and planning to perform surgery on a valued instrument, but it really paid big dividends in my case. I hope it does for you too! **NV**

ITEM	DESCRIPTION
Fixed resistors are 1/4 watt, 5% values.	
R1, R2	1.8K
R3, R4	3.6K
R5	10K linear potentiometer
R6 - R8	11K
R9, R10	100K linear potentiometer
R11	500K linear potentiometer
All capacitors are 16V or better.	
C1	10 pF disc
C2, C3	0.0047 μ F mylar
C4	0.022 μ F mylar
C5	0.047 μ F mylar
C6	1 μ F electrolytic
C7 - C9	10 μ F electrolytic
Semiconductor	
IC1	TL072 dual op-amp
Other components	
J1	1/4" phone jack, with DPDT switch
B1, B2	9V battery

Miscellaneous

Printed circuit board, IC socket, battery snaps, copper foil tape, knobs, knob indicators, wire, etc.

Most of these parts are available from any number of electronics suppliers. The more unusual copper foil tape, switching jack, and knob indicators are available from:

Stewart-MacDonald
21 N. Shafer Street
Athens, OH 45701
www.stewmac.com

PARTS LIST

By Craig A. Lindley

Post comments on this article and find any associated files and/or downloads at www.nutsvolts.com/index.php?magazine/article/october2014_Lindley.

BUILD THE LIGHT APPLIANCE

Readers of this magazine have probably come to realize that I am enamored with microcontroller projects that blink and flash. Examples that have been published in this magazine include:

1. The Infinity Portal
August 2011
2. The Desktop Contemplator
Dec 2012
3. Smart Necklace, July 2013
4. A Unique LED Clock
March 2014

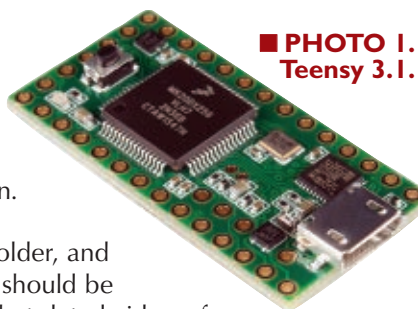
The availability of faster and faster microcontrollers and individually addressable RGB LEDs is a dream come true for someone like me. So, it probably comes as no surprise that when I saw a panel of 32x32 RGB LEDs (1,024 LEDs total) at a reasonable price, I jumped at the chance to build something with it. This is the same type of panel described in the article, "Giving Life to the Adafruit 32x32 RGB Matrix Panel" by Theron Wierenga in the July 2014 issue of *Nuts & Volts*.



I have dubbed this project "The Light Appliance" because it can be made to do so many fun, interesting, and creative things. In a nutshell, the Light Appliance is an Infrared (IR) remote controllable 32x32 RGB LED display that with the hardware and software I will describe:

1. Can run approximately 30 highly colorful graphics routines including plasmas and fractals.
2. Can function as an Open/Closed sign for a business.
3. Can function as an analog or digital clock with battery backup.
4. Can function as a decorative mood light.
5. Does real time decoding and display of animated GIF images in 32x32 format.
6. Has general, Christmas, Valentine's, Halloween, and 4th of July animation modes for your holiday parties.
7. Has time, date, and temperature display modes.
8. Can function as a canvas for painting with the remote control.
9. Can play numerous classic computer games such as Snake, Pac-Man, Ending, and Breakout.

If you have a fascination with projects like this, you can build a Light Appliance of your own. If you have modest electronic skills, can solder, and read a schematic you should be good to go. A somewhat dated video of the Light Appliance in operation is available at www.youtube.com/watch?v=VrOEJqX1-mE. Many new functions have been added to the unit since this video was made, but it will give you an idea of how things work.



■ **PHOTO 1.**
Teensy 3.1.

Hardware

The brains of the Light Appliance is a Teensy 3.1 microcontroller. This controller is much more powerful than your typical Arduino at only about a quarter of the size. **Table 1** details the relevant specifications; a Teensy 3.1 controller is shown in **Photo 1**.

Paul Stoffregen of pjrc.com designed and manufactures the Teensy 3.1. Through hard work, he has made the Teensy usable in the Arduino Integrated Development Environment (IDE) and has ported many of the most popular Arduino libraries to the Teensy, as well. This means you can develop code in the Arduino IDE and download it via USB to the Teensy just as you would if you were using an Arduino. He calls his adaptation of the Teensy into the Arduino environment, Teensyduino. (More on the Teensyduino software shortly.) Cheers to Paul for a job well done. After using the Teensy 3.1 in a couple of projects, I'm really impressed with its quality and

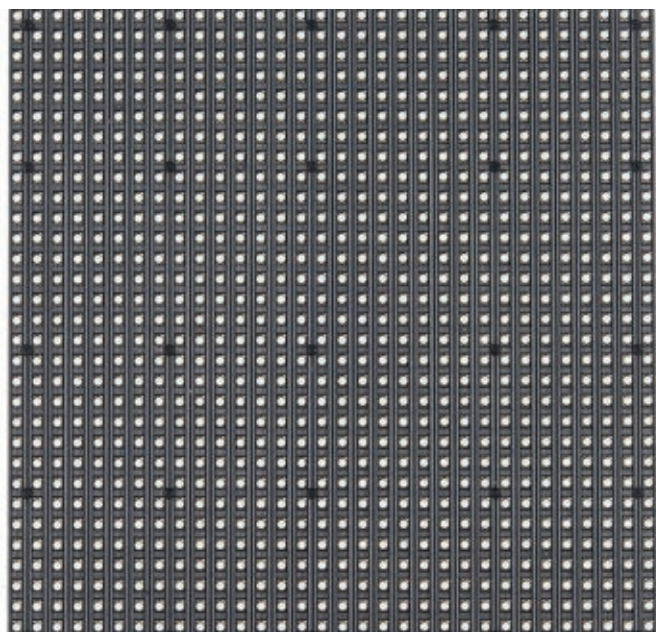
Feature	Spec
CPU – ARM Cortex-M4	Clocked at up to 96 MHz
Flash (program) memory	256 KBytes
RAM	64 KBytes
EEPROM	2 KBytes
DMA channels	16
Digital I/O	34 3.3V and 5V tolerant pins
ADC (analog-to-digital converters)	2 with 16-bit resolution
DAC (digital-to-analog converters)	1 with 12-bit resolution
Timer/counters	12 total
USB ports	1
Serial ports	3
SPI ports	1
I ² C ports	2
CAN bus	1
I ² S audio port	1

Table 1. Teensy 3.1 Specs

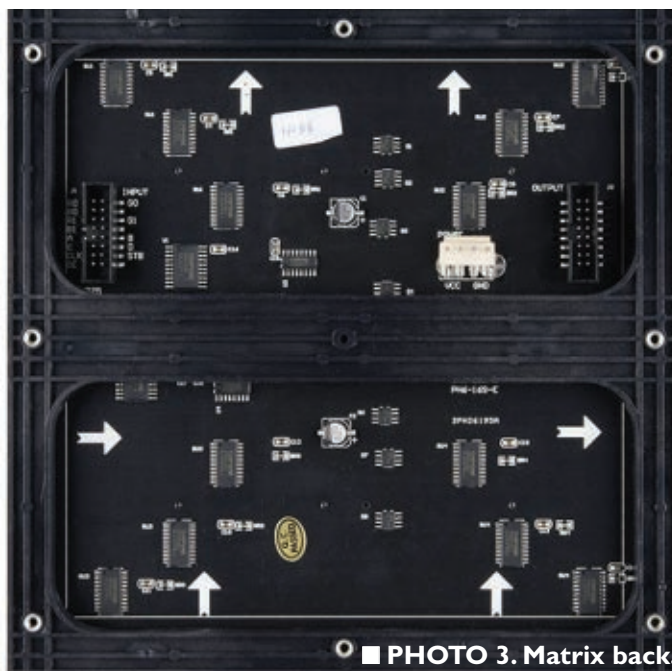
performance. I don't think I'll use a stock Arduino again.

Note, the Teensy 3.1 must be modified when used in this project. On the bottom of the printed circuit board (PCB), there is a trace between two pads that must be cut which prohibits powering the Light Appliance display from the USB port. These pads can be seen about halfway down at www.pjrc.com/teensy/teensy31.html in the Pinouts section. Check out the upper right portion of the rear view of the Teensy 3.1 labeled VUSB. An X-ACTO™ knife works great for making this cut.

The 32x32 RGB LED matrix we will be using is shown in **Photos 2** and **3**. I won't go into the specifics of the electrical interface required for driving the matrix since all of that is taken care of for you if you use the circuitry



■ **PHOTO 2.** Matrix front.



■ **PHOTO 3.** Matrix back.

PART DESCRIPTION

32x32 RGB LED Matrix Panel
comes with ribbon and power cables
Teensy 3.1 microcontroller
SmartMatrix Shield Kit for Teensy 3
5 volt 2 amp (min) power supply
DS18B20 optional temperature sensor
requires 4.7K 1/4 watt 5% resistor if
temperature sensor is used
IR Receiver/Detector
32.768 kHz crystal 12.5 pF
optional crystal for Teensy RTC
3 volt battery and battery holder
optional for Teensy RTC
SD/MMC memory card breakout PCB
SD memory card up to 2 GBytes
IR remote control

SOURCE

SparkFun part number COM-12584; Adafruit part number 1484
www.pjrc.com; SparkFun part number DEV-12646; Adafruit part number 1625
pixelmatrix.com; Adafruit part number 1902
SparkFun part number TOL-12889; Adafruit part number 276

SparkFun part number SEN-00245; Adafruit part number 374
SparkFun part number SEN-10266; Adafruit part number 157

SparkFun part number COM-00540; Digi-Key part 300-8303-ND, 300-8762-ND,
300-8763-ND, or 300-1002-ND

Can be a coin battery such as CR-2025 or CR-2032 or a couple of AA or AAA
batteries
SparkFun part number BOB-00204, BOB-12941, or equivalent
Anywhere
SparkFun part number COM-11759 - Make sure to get a CR-2025 coin battery
for the remote because it doesn't come with one.

■ FIGURE 2.

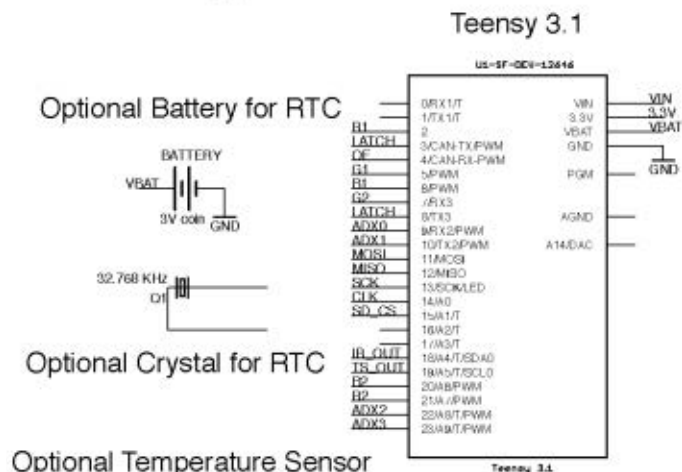
shown on the schematic in **Figure 1**. A Parts List is shown in **Figure 2**. The Light Appliance was designed with flexibility in mind. It is possible to build a base system without a Real Time Clock (RTC), without an SD memory

card, and without the temperature sensor if you so desire. Doing so, however, severely limits the functionality of the Light Appliance. If you want to include the RTC, you must solder a 32.768 kHz crystal onto the bottom of the Teensy

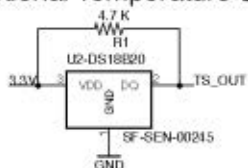
Power Input



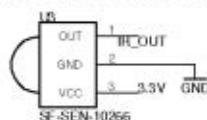
■ FIGURE 1. Light Appliance schematic.



Optional Temperature Sensor



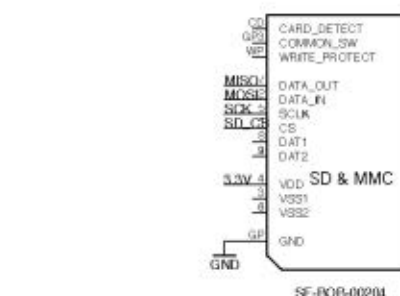
IR Receiver/Detector



Optional crystal for RTC connects to pads on bottom of Teensy

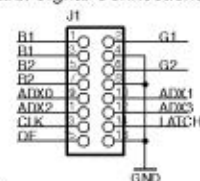
Teensy must have VUSB separated from VIN (via trace cut) and must have 32.768 KHz crystal soldered on back of pcb for RTC

Circuit can be built on breadboard or a pixelmatrix.com shield can be used. If shield is used the battery, SD card, temp sensor and IR receiver can be wired to expansion connector

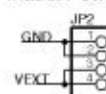


32x32 LED Matrix Panel SF-COM-12584

Matrix Signal Connections



Matrix Power Connections



Parts with SF- prefix are SparkFun parts

3.1 controller (see www.pjrc.com/teensy/td_libs_Time.html#teensy3). If you want to have a battery backup for your RTC, you need to incorporate the optional 3V battery with the connections shown on the schematic. If you want to include the temperature sensor, you must add a DS18B20 sensor and 4.7K resistor, and connect as shown. *NOTE:* This sketch will need modification if one or more of the optional hardware items are left off. We will show how this is done in a bit.

I have built two Light Appliance units. The first, I wired up point-to-point on a breadboard using the circuitry shown on the schematic. Unfortunately, it was kind of a mess, and eventually something shorted out and caused my Teensy to emit the magic smoke that we all try to avoid. Luckily, there is an alternative which saves some of the breadboarding effort. Louis Beaudoin of pixelmatix.com has made a SmartMatrix Shield Kit for Teensy 3 which makes for a much neater and robust build. I used his shield for my second Light Appliance. **Photo 4** shows the assembled shield with the Teensy installed. An expansion connector on the side of the shield makes most of the Teensy 3.1 pins available that are not used in driving the matrix.

All of the optional hardware components that I have designed into the Light Appliance still need to be built on a breadboard of some type and attached to the expansion connector on the shield. *NOTE:* The connection for the RTC backup battery is not made available on the expansion connector, so it has to be soldered directly to the Teensy PCB. Don't get me wrong. Building your unit on a breadboard without the shield is definitely doable if you take your time and double-check your work.

My Light Appliance is powered by a five volt/two amp DC power supply that is external to the device itself (it's a wall wart type of power supply). You, of course, could choose to build the power supply into your device. Two amps is the absolute minimum rating for the power supply. If all LEDs are run at full brightness — which would be blinding (think Time Square brightness) — a larger

power supply would be required. My Light Appliance sketch intentionally reduces the brightness of the LED panel to reduce power consumption and to keep the brightness at a level appropriate for my living room.

SD Memory Card Prep

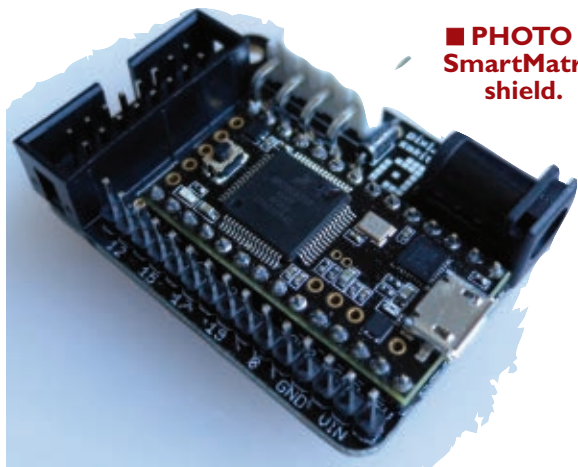
The Light Appliance uses an SD memory card (2 GB or less) for storage of animated GIF files. The SD card is prepared as follows:

1. The card must be formatted in the FAT16 format. You do this using a formatting program such as www.sdcard.org/downloads/formatter_4/ or by using the file manager/explorer on your computer. Don't do a quick format; do a full format of the card.
2. Create the following directories off of the root directory of the SD card:
 - A. *gengifs* – which will contain the general animated GIF files
 - B. *xmasgifs* - which will contain the Christmas themed animated GIF files
 - C. *halogifs* - which will contain the Halloween themed animated GIF files
 - D. *valgifs* - which will contain the Valentine's Day themed animated GIF files
 - E. *4thgifs* - which will contain the 4th of July themed animated GIF files
3. Download the file *Lindley_Animated_GIFs_Collection.zip* at the article link and unzip it.
4. Copy the animated GIF file from the unzipped file to the corresponding directories on the SD card.

NOTE: You can add your own animated GIF files to these directories as long as they are 32x32 resolution.

Software

The software for the Light Appliance consists of two major parts: the low level driver for the LED matrix panel and the Light Appliance sketch itself (*LightAppliance.ino* along with its associated files). The panel driver that I use was also written by Louis Beaudoin. This is an amazing piece of software that allows the panel to run in 24-bit full color mode with a 120 Hz refresh rate which results in a totally flicker free display. To make things even better, the panel is driven in the background using the Teensy 3.1 Direct Memory Access (DMA) hardware which makes almost all of the microcontroller's considerable processing power available to our application. Louis' driver also supports drawing pixels, lines, rectangles, circles, etc., to the display, in addition to the low level driver functionality. Props to Louis for making the driver available to everyone on an open source basis. There are other less capable drivers for this panel available but this is the best one I have found for this application.



■ **PHOTO 4.**
SmartMatrix
shield.



■ **PHOTO 5.**
IR remote.

All of the Light Appliance and supporting software is available free, but you must still configure your development computer to be able to use it. I develop on a Mac but you can do everything on a PC, as well. Links to all of the required and optional software are listed in **RESOURCES**. Use the following as a check list to make sure you have all the required parts:

1. If you haven't already done so, download and install version 1.0.5 or newer of the Arduino IDE.
2. Download and install the Teensyduino add-on.
3. Connect your Teensy 3.1 to your computer via a USB cable. You should see the LED on the Teensy blink once a second; the Blink sketch is loaded into the microcontroller during the manufacturing process.
4. Set the board in the IDE Tools menu to Teensy 3.1 and set the CPU speed to 96 MHz (overclock). Pick a serial port for use with the IDE's serial monitor that is appropriate for your development computer.
5. Load the Blink example sketch into the Arduino IDE. Click the verify button to compile the sketch to verify your setup.
6. Click the Upload button to program your Teensy 3.1 with the Blink sketch, then verify the LED still blinks and that no errors occurred.

Button/Key	Function
Power Symbol	If the Light Appliance is off, it turns it on. If in a submode like Patterns, brings you back up to the main mode selection mode.
A	Used in Mood Light mode to turn on all LEDs.
B	Used in Mood Light mode to turn off every second LED.
C	Used in Mood Light mode to turn off every third LED.
Up Arrow	Used to increase a value as in incrementing the minutes count of the RTC. Also used for navigation in the games.
Left Arrow	Used to select a previous function or used for navigation in the games.
Select or O	Selects the current function.
Right Arrow	Used to select the next function or used for navigation in the games.
Down Arrow	Used to decrease a value as in decrementing the minutes count of the RTC. Also used for navigation in the games.

Table 2. Remote Control Button Functions.

7. Close the Arduino IDE.
8. Insert your newly prepared SD card into its socket.
9. Download the file *Lindley_LightAppliance-PainterSketches.zip* and unzip it. Copy the *LightAppliance* and *Painter* directories into your Arduino sketch directory.
10. Download the file *Lindley_LightApplianceLibraries.zip* and unzip it. Copy the contents of the zip file into your Arduino libraries directory.
11. Restart the IDE, load the Light Appliance sketch, power up your Light Appliance, and click the Upload button to program your Teensy 3.1.

If all is well, you should see your display light up and be able to control your Light Appliance with the remote. The Light Appliance sketch assumes — by default — a full hardware build. As mentioned, the unit can be built leaving out some hardware components, but modifications to the sketch will be required to support this. Find the following code at the top of the sketch *LightAppliance.ino*:

```
// Define the optional hardware. If missing
hardware set value to 0
#define HAS_RTC 1
#define HAS_TEMP_SENSOR 1
#define HAS_SD_CARD 1
```

If you don't want to use the RTC, set *HAS_RTC* to 0. If you don't have the temperature sensor connected, set the *HAS_TEMP_SENSOR* to 0. If you aren't going to use the SD memory card, set *HAS_SD_CARD* to 0. By doing this, you remove the functionality the hardware device would provide. Removing the SD memory card functionality means the Light Appliance cannot display animations which, in my opinion, is the best feature.

If you would like to try out the Painter sketch, load it into the Arduino IDE and reprogram your Light Appliance with it. There is a read me file in the sketch directory which details how to use the program.

Controlling It

The Light Appliance is controlled via the nine button SparkFun IR remote control shown in **Photo 5**. The basic functions of the buttons are detailed in **Table 2**. Controlling the Light Appliance with the remote will become second nature after a little practice.

Packaging

Being a woodworker, I decided to build a custom case for my Light Appliance (see intro photo). I had a broken display case laying around which had nicely carved wooden sides, so I made my enclosure from that. An off-the-shelf packaging alternative is an 8" x 8" black shadow box from Michaels (item# 10223090) which is almost a perfect fit. If you use the shadow box, you might want to

RESOURCES

The following sources provide more information about this project and its background.

- Information about getting started with the Arduino can be found at <http://arduino.cc/en/Guide/HomePage>. The Arduino IDE can be downloaded from: <http://arduino.cc/en/main/software>. Note version 1.0.5 or newer of the IDE is required for use with the Light Appliance.
- For information about and/or to purchase of the Teensy 3.1 microcontroller board, go to www.pjrc.com. There is a forum for information about the Teensy line of microcontrollers at <http://forum.pjrc.com/forum.php>. Questions regarding the Teensy should be directed there.
- The Teensyduino (version 1.18 or newer) software development add-on to the Arduino IDE is available at www.pjrc.com/teensy/teensyduino.html as are instructions for installing it.
- Information about the SmartMatrix kit and/or the SmartMatrix driver can be found at www.pixelmatix.com. The most current version of the driver is available at <https://github.com/pixelmatix/SmartMatrix>.

- The collection of animated GIF files for the Light Appliance is contained in a file called *Lindley_Animated_GIFs_Collection.zip*. The Light Appliance and Painter sketches are contained in a file called *Lindley_LightAppliance-PainterSketches.zip*. The libraries required for the Light Appliance are contained in a file called *Lindley_LightApplianceLibraries.zip*. All of these files are available for download at the article link.
- For a look at the blog that started this project off, see <http://dangerousprototypes.com/forum/viewtopic.php?f=56&t=6125&p=56311>.
- Jason Coon ported the computer games to the Light Appliance.
- Other microcontroller based projects of mine can be found at www.craigandheather.net/celepage.html.
- For background information about GIF files, computer graphics, and image processing, see my book *Practical Image Processing in C*, published by John Wiley & Sons. This book is out of print but used copies are available from many sources.

experiment putting various materials between the LED panel and the glass front to diffuse the light from the LEDs. Even a single sheet of paper has a visible effect. Drafting film could be used for even more diffusion. A sheet of thin white translucent acrylic would really blur out the display

and produce some rather spacey effects. However you decide to package your Light Appliance, make sure to position the IR receiver/detector so that it's visible from where you plan on controlling your device.

Now, go light things up! **NV**





4D Systems designs, develops and manufactures intelligent graphics solutions using the latest OLED and LCD technology available, with custom graphics processors that enable both stand alone and host dependent solutions suitable for a very wide range of applications and projects.

<p>INTELLIGENT DISPLAY MODULES</p> <p>A perfect solution for any design requiring a brilliance of color, animation or images on any application</p>	 NEW Picadillo-35T			 NEW uLCD-220RD			 NEW uLCD-350T		
<p>DISPLAY MODULES FOR ARDUINO*</p> <p>Providing a quick and easy-to-use display solution for any Arduino project</p>	 uOLED-96-G2-AR			 uLCD-144-G2-AR			 uLCD-32-PTU-AR		
<p>DISPLAY MODULES FOR RASPBERRY PI*</p> <p>Broaden the variety of your Raspberry Pi projects by integrating a display solution</p>	 uLCD-24-PTU-PI			 NEW 4DPI-35			 uLCD-28-PTU-PI		
<p>DISPLAY MODULES FOR BEAGLEBONE*</p> <p>Attach a primary display to your Beaglebone Black with a 4D LCD CAPE</p>	 4DCAPE-43			 4DCAPE-43T			 4DCAPE-70T		

*Trademarks do not belong to 4D Systems. All trademarks belong to their respective owners.

www.4dsystems.com.au
f
www.facebook.com/4DSystemsAU
t
www.twitter.com/4DSystems

1963 Zenith MK2670 Stereo Repair

By J.W. Koebel

Post comments on this article at www.nutsvolts.com/index.php?/magazine/article/october2014_Koebel.

Vintage gear is really special.

There's just nothing like the unique sound, look, and feel of an old tube hi-fi glowing away and playing your favorite record. Unlike a lot of modern gear, they can still be worked on and fixed up by a dedicated hobbyist.

I'm lucky to get to see and work on a lot of vintage radios and stereos at my small shop in Seattle, where I repair all kinds of gear from early tube radios going up to the modern era. This 1963 Zenith hi-fi stereo

console is one of my favorites. The classic styling would look great with modern accents, too — it would look just as good with a flat-screen TV on top instead of a typewriter, and could even play its audio (**Figure 1**).

This was a top-of-the-line piece in its day, built by hand in the USA with precision electronics, carefully selected speakers, and a heavy wooden console cabinet made to be a prominent piece of furniture in the home. With a total of 19 tubes, it could really heat up a room.

This particular model came with a pair of efficient, fantastic sounding three-way speakers with powerful magnets driving a 12" woofer, twin smaller cone midranges, and a horn tweeter. When running properly, it sounds lively and musical — so when it started to sound worse and worse and take a longer and longer time to warm up, its owner knew something was going wrong. I made a house call to remove the guts; there were two big metal chassis: one for the amplifier and power supply; and a second for the tuner and pre-amp (**Figure 2**).

The front control panel is a masterpiece of space age design. It looks like the control panel of an old rocketship.



Figure 1. The patient: Zenith's MK2670 stereo console.



Figure 2. What a beautiful space age dial!

Preserving a piece of stereo history ... a tube console stereo repair story.

Don't just plug in a piece of vintage gear you find to see if it works! This can be dangerous and might cause a fire or shock, depending on its condition. Solid-state gear after about the mid '60s can be powered on safely to see if it hums or makes any sound, but most tube gear from the early '60s and before probably needs service before it will work safely and reliably. Early electronics used parts which break down with age just sitting on a shelf, and it only takes a few seconds for something to go seriously wrong and burn up an important component.

I think that's one of my favorite things about this stereo. It has quite a few functions: there's the function selector on the left; the tuner, loudness, and balance on concentric controls in the middle; the stereo function switch; the power switch along the bottom; and along the side, separate treble, bass, and presence controls. It's fully customizable (**Figure 3**).

Digging into the Repair

The amplifier chassis — hidden inside the cabinet — is a lot more minimal. There's the output tubes: a pair of 6BQ5s for each left and right. You might know them as EL84s, and in this amp they produce a nice clean sound with plenty of power for the efficient speakers they're driving (**Figure 4**).

It's pretty chaotic underneath. By this time, they'd invented printed circuit boards but they hadn't taken over yet, and many consumer electronics just used good old fashioned point-to-point wiring. It works, but it can look like a hot mess! With the components spaced so far apart, though, it's easy to give it a quick look-over for obviously bad parts — and there's a problem that shows up right away (**Figure 5**).

This capacitor is attached to the power amplifier circuit — and it's blown a piece of its plastic casing clean off! Modern capacitors are made of durable and reliable materials — often plastic and metal films and ceramics. Back then, though, these materials had just started to become available, and most electrical components were still ultimately made of paper and foil with special packaging. This one used a plastic and epoxy package but over 50 years, the paper and foil degrade and start to leak electricity. This creates a heat build-up that can release gasses which expands in the sealed body, and ... pop! Off goes a piece of plastic.

Even with this failure, the amp continued to try and play — vintage gear can really take a beating. Once the parts get to this stage, though, there's no sense in just replacing a few. They're all the same age and they're all



Figure 3. The amplifier chassis model 7K31.

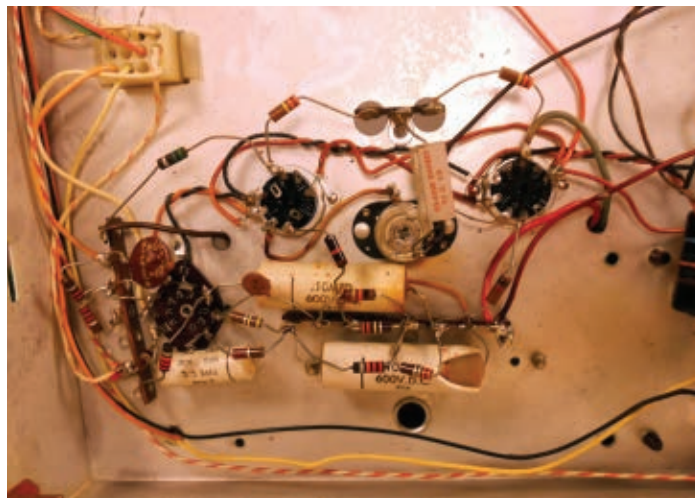


Figure 4. Wiring around one amplifier channel's output tubes.



Figure 5. This capacitor blew a piece of casing clean off.



Figure 6.
The
Precision
10-20
tube
tester.

going bad, even if a few have somehow survived this long. It's time for a complete overhaul to make sure it stays a great performer for a long time to come (**Figure 6**). It's handy to have some special equipment for working on tube gear, but you don't really need much more than a

As with all electronics projects, take proper safety precautions while servicing a vintage radio or stereo. General precautions always apply, but tube electronics run on much higher voltages than solid-state gear, plus tubes get extremely hot while operating. Be careful of unsafe vintage wiring schemes that put mains voltage on exposed bare metal parts of the chassis like control shafts. Go slow and be careful!

soldering iron and multimeter to take care of most of the basics. In this case, though, I started off testing the tubes; a few in the radio needed to be replaced but most were good. This radio was handed down from the current owner's parents, and they'd looked after it over the years, replacing some of the power tubes as they'd worn out, but most of the others were the original Zenith parts (**Figure 7**).

I went slowly, replacing the components as close to their locations as possible. Old capacitors were usually made of paper and foil; old carbon composition resistors tended to absorb moisture from the atmosphere over the years and change in value. Resistors which dissipate more power and put out more heat tend to have it worse.

I tested a sampling of the resistors to check their tolerance, paying special attention to the bias resistors. Only a few had drifted past their marked tolerance bands and needed to be replaced. Zenith picked good quality parts when they built this originally. Most of the resistors were stable, even over more than 50 years (**Figure 8**).

The amplifier and power supply were great to work on, with a ton of room and a clean easy-to-follow layout. The tuner and pre-amp chassis was a different story. It's a densely packed multi-layer maze of different construction resistors and capacitors, mixed in with a few coils and sockets for good measure.

Zenith mixed and matched a few styles of capacitors

Tubes were designed to last a long time, and they don't generally go bad on a shelf. So, unless it was just rode hard and put away wet its entire life (or hit by a power surge), most of the tubes you find are likely to be good. Some tubes which develop a white coating inside have lost their vacuum over the years, but most will probably be in good shape. Even if not, you can track down new old stock replacements for most tubes without too much trouble.

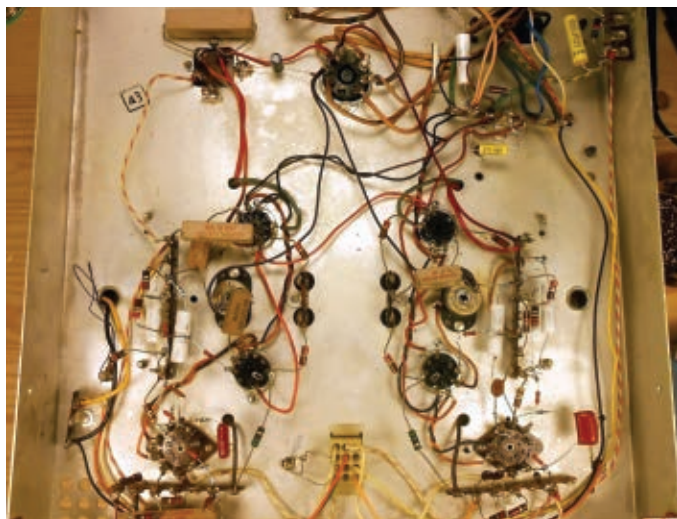


Figure 7. Underside of the 7K31 amplifier after replacing the bad capacitors.



Figure 8. The chaotic underside of the 12K25 tuner chassis.



Figure 9. There's a big size difference between vintage and modern capacitors!

while building this, which makes it a bit tough to tell if something is a replacement or original. There's the "black beauties" – the black cylinders with color bands similar to a resistor. There's more of the epoxied plastic paper capacitors in white; a handful of classic cardboard capacitors; and a handful of assorted early film or paper/mylar caps – not to mention two styles of disc capacitor, and several mica "domino" rectangular capacitors.

I had to work with needle-nose pliers in each hand for most of the tuner section repairs to thread the parts exactly where they were originally. These high performance circuits were sensitive to positioning, so even changing where the wires run or the components hang can cause problems with reception and feedback (Figure 9). The tuner section had a mix of older style and newer style capacitors. The Sprague is probably a coated paper model; I always make sure to replace ones like that when I see them so they don't cause problems later on (Figure 10).

Most tube amplifiers used output transformers to connect to the speakers. Zenith ran the leads for both speakers to a terminal strip on top of one transformer with convenient color-coded labeling. One thing that's pretty unusual about this Zenith is the output transformers had separate windings for different drivers. The 12" woofers are on their own secondary from the horn and midrange drivers.

I've run into a few Zeniths which used a similar scheme, but I've never seen another manufacturer do this. (Feedback windings and matching taps are pretty common – but multiple driven secondary windings seem to be pretty rare!)

Finishing Up

I hooked up a whole mess of clip leads to four bench speakers for testing since I'd left the original drivers mounted to the cabinet. With resistors and capacitors

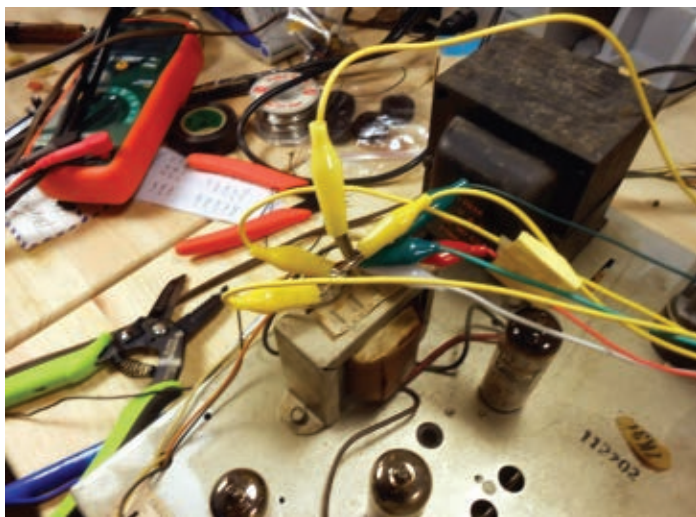


Figure 10. A rat's nest of test leads connects the amplifier to a set of test speakers.



Figure 11. Adjusting the bias on one of the stereo amplifier channels.

replaced, it's safe to run the stereo for the rest of the process: alignment, bias adjustment, and burn-in testing. I started with the bias adjustment since that will ensure safe amplifier operation and good sound quality through the rest of the process (Figure 11).

In this photo, I'm adjusting the bias potentiometers. I hooked my multimeter up to the underside while making these adjustments since (at the time) I didn't notice the convenient top side test points they provided. Oh well! Both channels were really pretty close already, but I tweaked them to perfection for good measure. With the amplifier section sorted, it was time to move on to the tuner alignment.

For a receiver, alignment is the process of adjusting the tracking and reception of the tuned circuits for the best performance. If you've ever owned an older piece of

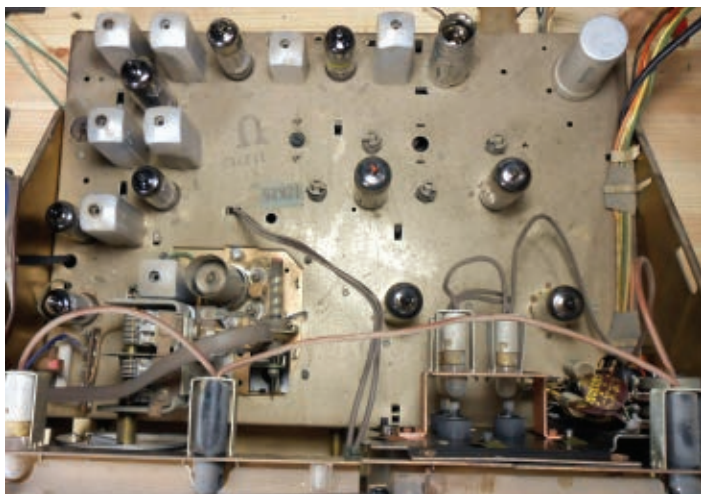


Figure 12. The tuner chassis showing all eight of the RF transformers to adjust.

gear like an FM radio, you know that sometimes the dial indicator can get out of sync with the stations, making them come in at the wrong locations on the dial. Sometimes, components drift and settings change, and this can cause distortion in the audio or weak reception. With an accurate signal source, you can adjust the tuned circuits in the receiver to bring everything back to where it should be.

Alignments can be a bit tricky. There are several adjustments to make in an alignment for a receiver like this one since there are separate adjustments for every stage for both AM and FM independently. In all, the radio needs the antenna, front end RF amplifier, dial tracking on both the high and low sides, and the intermediate

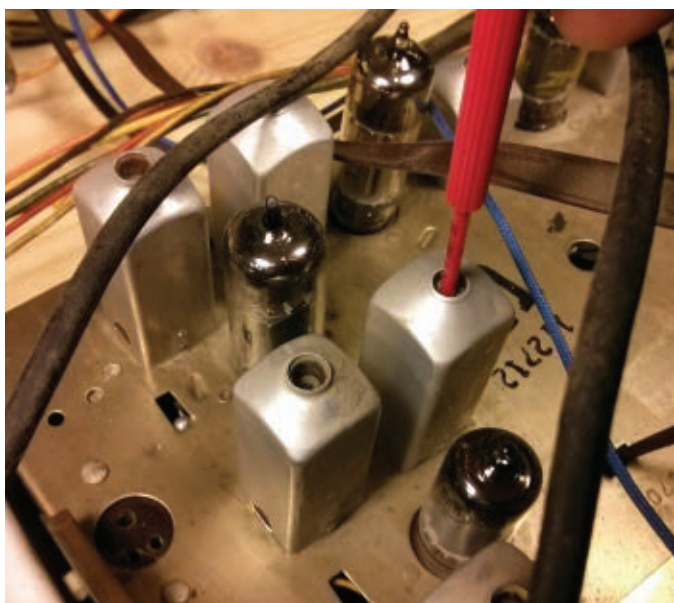


Figure 13. Adjusting one of the RF transformers with a non-inductive alignment tool.

Guglielmo Marconi developed the first commercial radio system in 1894, but it wasn't until 1906 when Reginald Fessenden and Lee de Forest developed Amplitude Modulation (AM) that radio started to explode, and it didn't make it into most households for another two decades. The technology is mostly unchanged since then. A radio made back in 1924 will happily tune in one of today's AM stations.

frequency stages all to be re-tuned. Plus, on the FM side, there's a series of additional adjustments for the stereo functionality. All told, there's eight RF transformers in this radio, plus four coils used in the FM stereo de-multiplexer (**Photo 12**). It's fairly easy to do an AM alignment "by ear" using nothing but an adjustment wrench and whatever broadcast stations you happen to be able to receive with a short antenna. AM radio is a very simple technology that's been around over 100 years, so there's really not much to it in most cases.

An FM alignment is a lot more challenging, though. It's possible to do an FM alignment with a multimeter and an AM signal generator (and a fair amount of patience), but for best performance you generally need a sweep signal generator or an FM signal generator and an oscilloscope in addition to the multimeter. Trying an FM alignment by ear usually doesn't turn out well (**Photo 13**).

Since there's so many adjustments, I didn't take a photo of each individually, but I did a full AM and FM alignment. The AM side only needed minimal adjustment as it was coming in pretty close. The FM side was still in great shape, needing just minor adjustments to bring it back to full performance. Miraculously, the FM stereo tuning was in perfect shape and didn't need any adjustment at all. Zenith's quality really showed here; the adjustments stayed solid for 50 years (**Figure 14**).

All told, this vintage hi-fi stereo console took quite a bit of work to clean up, but it turned out fantastic. I replaced a few burned out light bulbs on the dial to make it really shine. It was a real shame when I had to take it back to its owner after letting it play on my bench for its



Figure 14. All lit up like the cockpit of a space ship.



Figure 15. Out with the old, in with the new!

burn-in period. It sounded so nice!

I removed quite a few bad parts from the amplifier and tuner while it was on the bench: resistors, capacitors, bulbs, and a couple of tubes which tested bad. It looks like a handful all laid out (Figure 15).



Figure 16. Home sweet home.

It took me about 24 hours of working time, plus a few more for research and testing to bring this unit fully back to life. With the new parts and tubes and a full alignment, it's back to playing as good as it did when new, and it will continue to be a great décor piece and functional stereo for many years to come (Figure 16). **NV**

2014 INNOVATION CONTEST

INSPIRE • INNOVATE • BUILD





Custom Technology for Critical Applications
www.bocabearings.com

WIN CASH & PRIZES




LEARN MORE
AND SEE WHAT OTHERS ARE DOING AT:

WWW.BOCABEARINGS.COM/INNOVATION-CONTEST



SF02 Laser Rangefinder

Fast and accurate distance measurements from 0-40 m (0 to 130 ft). Not affected by wind, noise, ambient light, terrain, air temperature, or changes in barometric pressure. *No calibration required* – ready to use right out of the box. **#28043; \$349**

Order www.parallax.com
or call 888-512-1024
(M-F, 8am-5pm, PDT)



Prop Dropper 2

By Chris Savage



Post comments on this article and find any associated files and/or downloads at www.nutsvolts.com/index.php?/magazine/article/october2014_Savage.

The Prop Dropper 2 allows you to drop scary Halloween props such as bats and spiders onto unsuspecting trick-or-treaters and play scary sounds at the same time! Built around the Parallax Propeller microcontroller, this project is highly customizable and expandable.

History

In the October 2009 issue of *Nuts & Volts*, Vern Graner published his Prop Dropper project using the EFX-TEK Prop-1 controller, which is based on the Parallax BASIC Stamp 1. The project used a Parallax PIR sensor to detect motion, which then triggered a pair of servos to drop the 'critter' onto the 'victim.' If you haven't seen this article, I highly recommend checking it out. Inspired by the simplicity of this project, I discussed with Vern the possibility of making an upgraded version, and the Prop Dropper 2 was born!

How It Works

The Prop Dropper 2 is very similar to the original in that it waits until a person is detected and then drops a prop nearby to scare them. As mentioned, in addition to dropping the prop, a sound (.WAV) file is played to add to the effect. But wait! There's more! The Prop Dropper 2 also waits until the person moves again and then drops a second prop and plays a second sound file giving them an almost

immediate second scare! You're actually not limited to just two props and sound files. The Propeller chip provides sufficient I/O and resources to realize many droppers and the flexibility to configure things the way you want. More about that later.

When powered up using the



FIGURE 1. Servo/spool mechanism.

code supplied at the article link, the Prop Dropper 2 will drop both props, wait three seconds, and then wind them up again while playing an evil laughing sound. This serves two purposes. First, it makes sure the props are both properly initialized in case the power was shut off in the middle of a wind up cycle. Second, it makes sure your sounds are playing properly.

Once the props are back in position, a Parallax (PING))) ultrasonic range finder is used to detect when a person enters the target area. Once they do, the first prop is dropped and an accompanying sound file is played. When the person starts to move forward again, a second prop is dropped and that sound file is played. After the person leaves, the props reset and the system is ready to scare the next victim.

While a PIR sensor can be shrouded to focus the detection area to be more limited, I opted to use the (PING))) sensor. This gives me the ability to see not only when someone is in range to drop the prop on, but I can detect their distance from the sensor. This means I can control which prop drops and when.

Like Vern's original Prop Dropper, this unit uses two servos for each prop we're going to drop. Each pair of servos consists of a tilt (standard) servo and a wind-up (continuous rotation) servo joined together. The tilt servo is responsible for tipping the wind-up servo, which inherently tilts the spool that holds the string the prop dangles from. By tipping the spool vertically, the string unravels all at once resulting in the prop dropping suddenly until it reaches the end of the string and stops. **Figure 1** shows a completed dropper assembly installed on a board.

When we want to reset the prop, we simply move the tilt servo to set the wind-up servo (and therefore the spool) back to a horizontal position and then rotate the wind-up servo to raise the prop back up, ready to drop again.

Getting Started

You will need to copy sound (.WAV) files to the microSD card from your computer. A card reader or adapter may be required to connect the microSD card to your computer. I have tested the WAV player object with 11 kHz and 22 kHz mono WAV files in both an eight-bit and 16-bit format. I am unclear if other formats are supported by the object used. You can use a free audio utility such as Audacity to record, edit, and modify sound files.

In the Parts List, you will find the main Parallax components I used in this project, as well as other items used in the build. The first thing I did was set everything up on my desk as a prototype so I could make sure I had all the required objects for the hardware, and so I could center/calibrate the continuous rotation servos. In **Figure 2**, you can see my setup.

Prototyping is essential for hashing out designs like this because you have software and hardware



FIGURE 2. Prototyping the Prop Dropper 2.

components mixed together. In this case, I needed to synchronize the motions of several servos (both standard and continuous). I also tested each section independently before connecting everything together to make it easier to debug later. Servos are inherently slightly different from each other, so you have to test to find the right pulse values to make each servo do what you want.

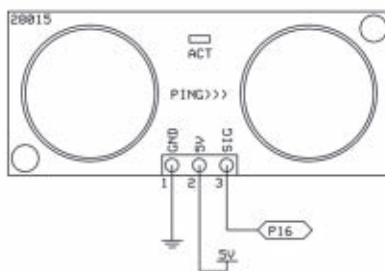
Notes:

All connections are in relation to the Propeller Activity board.

Servo voltage jumper set to 5V.

All connections use servo headers.

Components shown are not to scale.



Schematic.

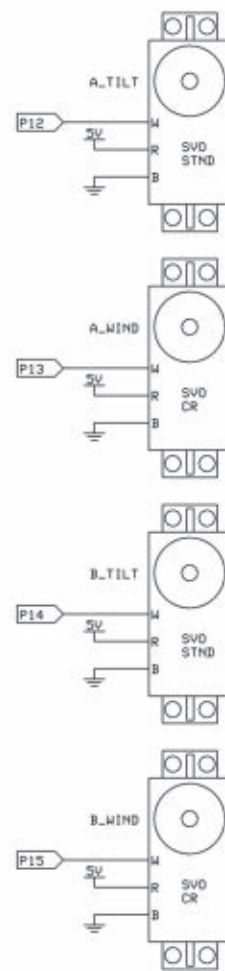




FIGURE 3. Building the servo frames from brackets.



FIGURE 4. Attaching the servo horn to the wood spool.

Building the Hardware

If I used this system in an actual haunted house capacity, things will likely need to be set up much differently. Each dropper assembly will need to be where it can be positioned effectively. A suitable audio system would need to be installed, etc. In this article, I will describe how I built the basic demo unit and offer some

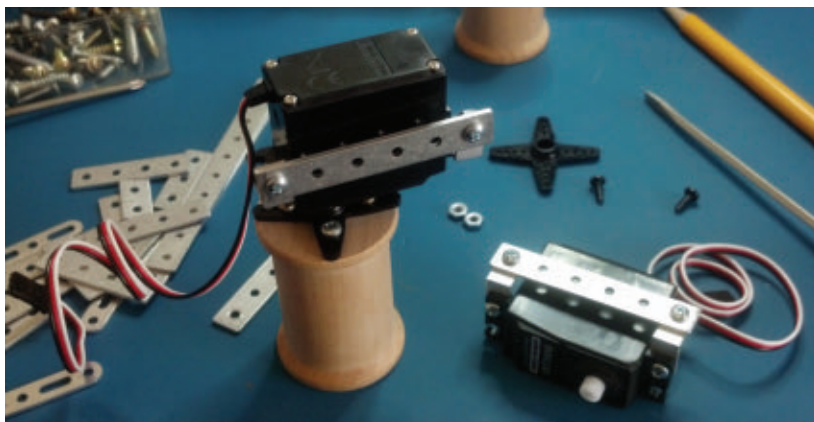


FIGURE 5. Wind-up stage completed.

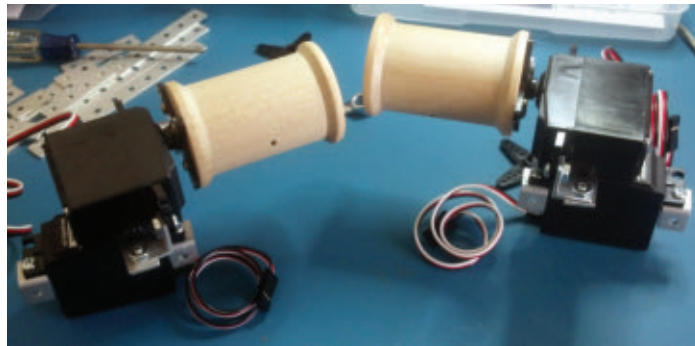


FIGURE 6A. Completed dropper assemblies.

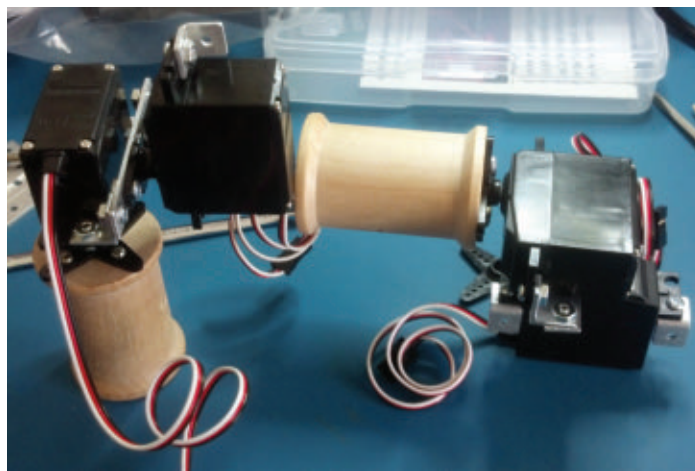


FIGURE 6B. Alternate angle.

ideas for customizing and expanding it. Additional resources for some of these options are at the article link.

The first thing to do is put together the prop dropping assemblies which consist of one standard servo and one continuous rotation servo. In Vern's original article, he hot-glued most of the parts together. I looked through my parts bins and found many miscellaneous brackets, so I decided to connect the servos in this manner for a couple reasons. One, if a servo was damaged, replacement would be easier. Also, I could handle heavier props without worrying about the servos coming apart. **Figure 3** shows some of the servos with the various brackets needed to connect everything.

The standard servos horns were connected to the bracket that ties into the continuous rotation servo. The standard servos then mounted to my wood platform via some right-angle brackets. I chose to use wood spools available at any craft store and screwed the horn from the continuous rotation servo into the spool (**Figure 4**). It's important to make sure the horn is centered before drilling into the spool, otherwise it will wobble when winding up the prop. This might cause the prop to bounce and not reset properly.

The hole in the spool allows you to screw the servo horn into the continuous rotation servo. With the brackets attached, that completes the wind-up stage of the servos.

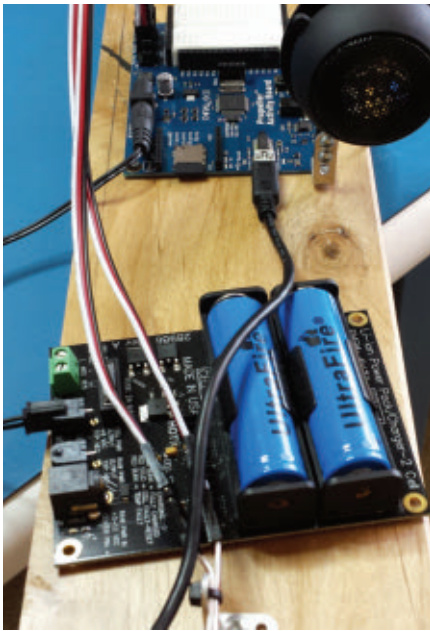


FIGURE 9. Power supply for testing.

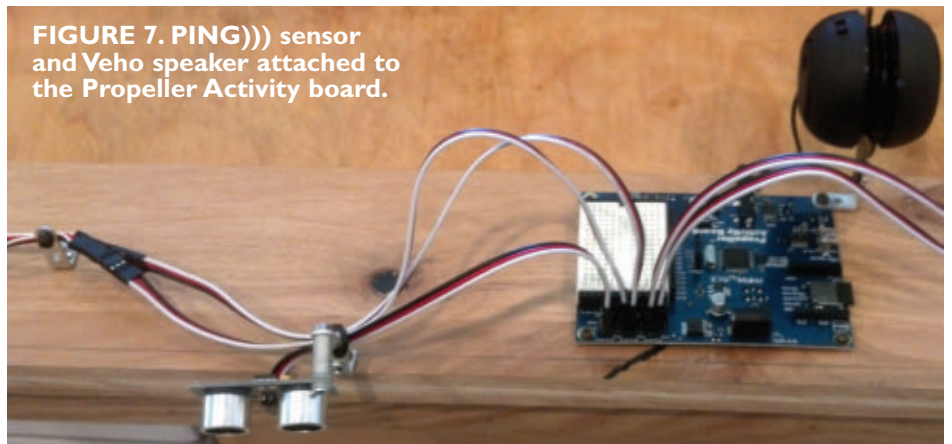


FIGURE 7. PING))) sensor and Veho speaker attached to the Propeller Activity board.

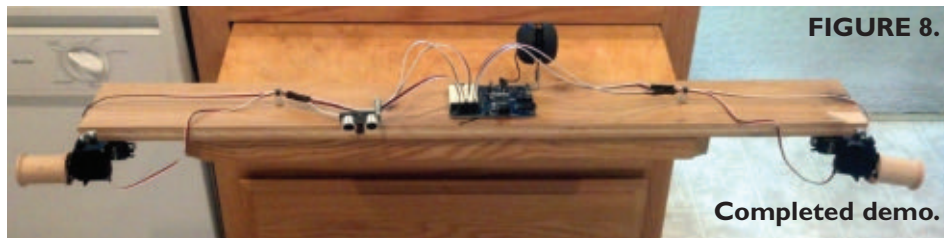


FIGURE 8.

Completed demo.

Figure 5 shows a completed wind-up stage and the other continuous rotation servo ready to have the spool attached to it. Next, we'll attach the continuous rotation servo to the standard servo horn, completing the entire drop assembly (**Figures 6A** and **6B**). This is duplicated so there are two droppers in the system. Each pair of servos was coupled using the same pieces of hardware. I cut the longer brackets down so they connected to the right-angle brackets mounted to the servos.

Now, it's time to connect these completed dropper assemblies to the Propeller Activity board. Take note of the I/O pin assignments in the code when connecting everything to it. My servo cables weren't long enough, so I got a three-wire extension cable pack and used several three-pin single row headers to extend the servo cables to the board as well as to the PING))) sensor. I used a speaker and mounting bracket for programming and

testing (**Figure 7**). Refer to the Parts List for specifics.

All the servo connections and the PING))) sensor connect to the servo headers on the Activity board. The microSD card is in the socket and the speaker is plugged into the audio jack.

Completed Hardware

In order to realize a working demo in a reasonable space, I attached all my parts to a 3' length of plywood to use as a platform. **Figure 8** shows the demo completely assembled and ready for the props to be attached.

The power supply for the demo is a lithium-ion battery pack. I find these very useful for providing portable rechargeable power for my projects.

Writing the Software

As is typical for many programs based on the Propeller chip, the top object was written completely by me while several other objects from various sources were referenced to make use of some of the hardware. I implemented the *Ping* and *Servo32* objects from the Propeller library, as well as the KISS WAV Player V2 written by Kye from the Parallax forums.

The program initializes the *servo* and *WAV* objects, then starts a loop where the droppers go through a reset phase, then wait for a person to scare. While the wind-up servos were idle, I adjusted the potentiometer on them so they didn't spin at all. This is the typical center calibration required for continuous rotation servos. It took several tries to get the exact pulse values to use for the tilt servos to get them to drop vertically and reset horizontally. These values were different for each tilt servo.

The same testing was required to get the wind-up directions and speeds. All these values get plugged into

Parts List

Parallax Parts:

- (1) - Propeller Activity Board (#32910)
- (1) - 2 GB microSD Card (#32319)
- (1) - PING))) Ultrasonic Sensor (#28015)
- (2) - Parallax Standard Servo (#900-00005)
- (2) - Parallax Continuous Rotation Servo (#900-00008)
- Assorted Three-wire Extension Cable Pack (#751-00010)
- Three-pin Single Row Headers (#451-00303)
- Veho Speaker (#900-00018)
- Mounting Bracket (#725-32905)
- Lithium-ion Power Pack Full Kit (#28989)

Miscellaneous:

- Plywood
- Wood spools
- Hardware for your specific application/setup

Resources

Project Pages
www.savagecircuits.com/propdropper2

Parallax, Inc.
1-888-512-1024
www.parallax.com
support@parallax.com

the correct constants at the beginning of the code. I can guarantee the default values won't work. Depending on the file names of your sound files on the microSD card,

you will most likely need to edit the names in the code where the sounds are played. These are commented to make them easier to find.

Ready for Testing

The demo unit was placed on top of a ladder since that was the tallest platform I had available. I attached a bat and a spider that my wife picked up from a craft store. I loaded the microSD card with both a

bat screech and scream WAV file, and adjusted the code accordingly.

When the bat drops, it makes a screech sound; when the spider drops, it makes a female scream/shriek sound. Of course, you can use any sounds you want or even record your own.

Modifications and Expansion

Typically, when I create a new project, I actually come up with different ideas for how things could be done while I'm building or testing the code. This time was no exception. As mentioned, the ZIP file at the article link will contain not only the schematic and code used for what is covered in the article, but also two variants I experimented with. V1.0 provides a single sensor for detecting people and a simple timed rewind cycle similar to what was used in Vern's original Prop Dropper. V1.1 adds an infrared encoder to the wind-up servo, so that it will wind based on turns instead of time. V1.2 adds an extra PING))) sensor and allows each prop dropper to work independently rather than being synchronized with one sensor.

You can add additional dropper assemblies and even more sensors. One Propeller Activity board can control many sensors and servos, allowing for a good amount of expansion.

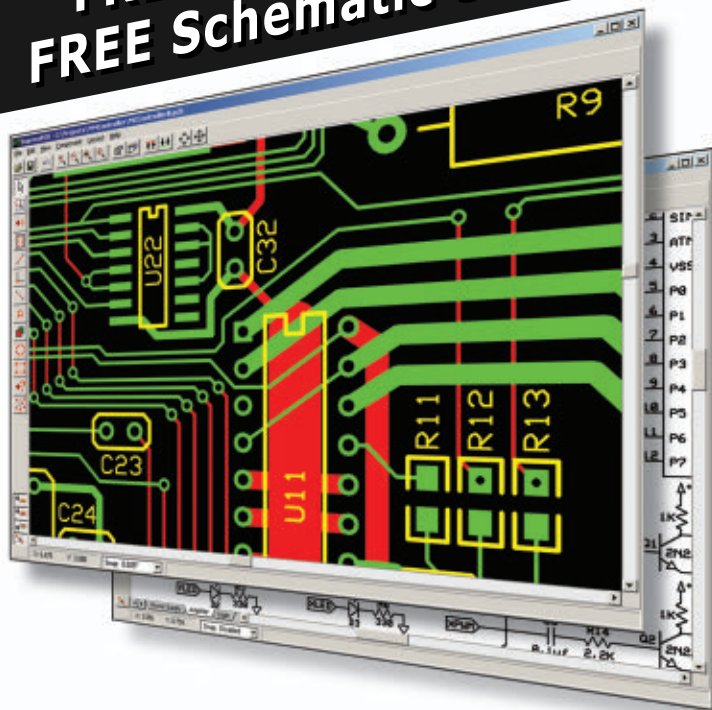
An XBee module could be added to integrate this system to another dropper or related project, synchronizing them. For more discussion about this or for questions or comments on the information given, please visit the project page listed in Resources.

Final Thoughts

The options here are nearly endless. Just put your imagination to work and you'll soon come up with some very interesting and unique projects.

Have a Happy Halloween. I hope this project provides a welcome addition to your haunted house! **NV**

\$51^{For 3} PCBs
FREE Layout Software!
FREE Schematic Software!



- 01 DOWNLOAD our free CAD software
- 02 DESIGN your two or four layer PC board
- 03 SEND us your design with just a click
- 04 RECEIVE top quality boards in just days

expresspcb.com

A photograph of a two-story house at night. The house has dark green siding and white trim. A large, full moon is visible in the upper right corner. The house is decorated with digital ghost projections. In the upper window, two ghostly figures are visible. In the lower window, a ghostly figure with outstretched hands is visible. The title 'Haunting With Video Projectors' is written in a large, white, dripping font across the upper half of the image.

Haunting With Video Projectors

By Anthony Petrone

One of my favorite new trends when it comes to decorating for Halloween is using what is called "digital decorations." These are essentially digital animations that have been created to use for props during the Halloween season. These digital decorations range from family friendly frights to down-right macabre and ultra-violent scares that can give even the most hardcore of Halloween fans a good startle.



Companies such as AtmosFearFX offer a wide variety of digital decorations from friendly shadows to use in your upstairs windows, to home-invading zombies punching through your wall (**Figure 1**). With a little hunting online, you can find free animations that other Halloween fanatics have created and uploaded to places such as YouTube and various Halloween forums. You can use your imagination and creativity in numerous ways when it comes to setting up these digital decorations, but perhaps the easiest way is through the use of projectors.



FIGURE 1. Projection of zombies breaking through a wall from AtmosFearFX.

Projectors have come a long way over the past few years. Evolving from large bulky items (**Figure 2** and **2A**), projectors are now small sleek devices that you can hold in a one hand (**Figure 3**). Some projectors can even be found in pocket-sized offerings now, which can lead to some really neat uses when it comes to decorating for Halloween.

The price for purchasing a projector has drastically changed, as well. While some projectors can still run in the thousands of dollars, there are plenty that can be purchased for way less. I was able to come across two small 3M mobile LED projectors last year online for \$99 each.



FIGURE 2. Professional installer from masteravservices.co.uk mounting a bulky projector.

There are other smaller projectors available for as little as \$50 through various online resources; just do a Google search to see what you can find. With a little effort, you can get a projector to fit your budget.

Once you have a price range in mind, there are a few other things to consider when purchasing a projector. A unit's brightness is measured in lumens, and most projectors will list the lumens/output right on the device. The higher the number, the brighter the projector will be.

Don't feel like you have to purchase a projector based solely on its output. Surrounding light pollution can greatly affect a unit's ability (**Figure 4**).

If the digital animation will be set in a dark area, a lower lumen projector will work just fine. If you are battling a lot of nearby light pollution — such as street lights or other sources — then be sure to look for units with a decent amount of output.

If you are looking to haunt a large scene (like your upstairs window with a passing ghost), I recommend a projector with at least 2,000 lumens. If you want to do something a bit smaller in scope and size (such as a haunted portrait or singing pumpkin), a unit with less lumens will do the trick.

Resolution is also something to consider when



FIGURE 2A. Bulky ceiling mounted version.

FIGURE 3. Handheld projector.



FIGURE 4. Lumen chart.

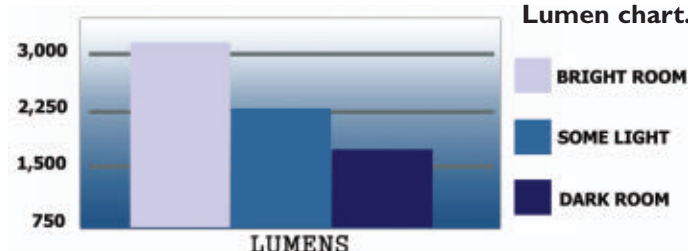




FIGURE 5. DVI - VGA.

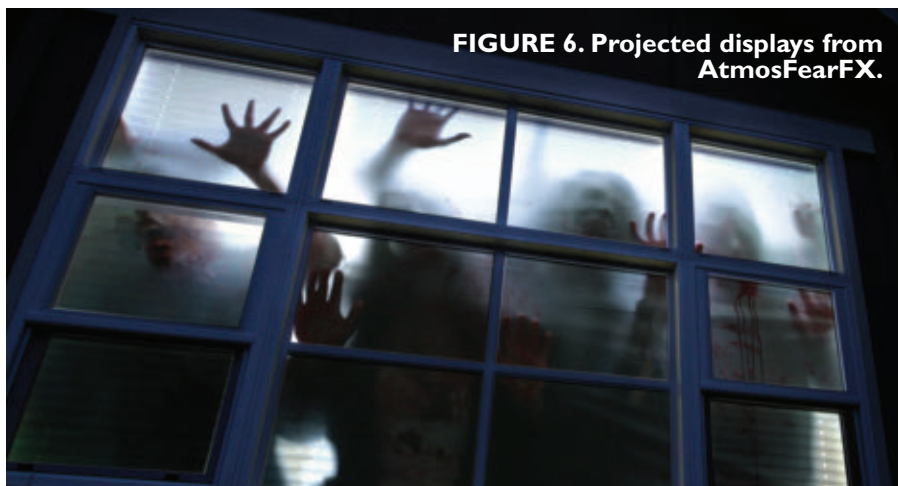


FIGURE 6. Projected displays from AtmosFearFX.

purchasing a projector. Much like purchasing a TV or computer monitor, the higher the resolution, the more detail you will achieve with your image. While it's important to have a nice resolution for watching movies or playing games, with a projector it's not as important when using it for a digital decoration. In most cases, your display will be ghosts, shadows, and other such haunting things. A little fuzziness will only add to the creepy factor.

In addition to a projector, don't forget music/sounds to play, as well! Most projectors will connect directly to a laptop or PC with either a DVI cable or VGA cable (**Figure 5**), and will allow you to play right from your hard drive. If having a computer near your projector is an issue, most units will also have other input options allowing you to use a DVD player or even a digital media player. Be sure to set your DVD player or media player to repeat/loop to keep the scare going.

Once you have a projector and a playback device picked out, it's time to set everything up. Perhaps the easiest digital decoration to create is a haunted window (**Figure 6**). With numerous digital decorations available, windows make the perfect place to display them. Because you can't simply project the image onto the window itself, it's necessary to set up what's known as a scrim.

This is a piece of material that appears to be opaque until lit from behind. The easiest solution to this is a cheap white plastic shower curtain. Simply raise your blinds and hang the shower curtain in the window.

Once the curtain is in place, make sure all the lights in the room are off and position your projector behind it. You will need to adjust the distance between the window and your projector until you feel the image size is adequate and provides a life-like representation of the particular display you are using (**Figure 7**).

Be aware the image will appear reversed to people viewing it from outside, so keep this in mind if you are using any displays that might include text or other such things. If everything is set up correctly, you should now have a haunted window complete with ghosts and other

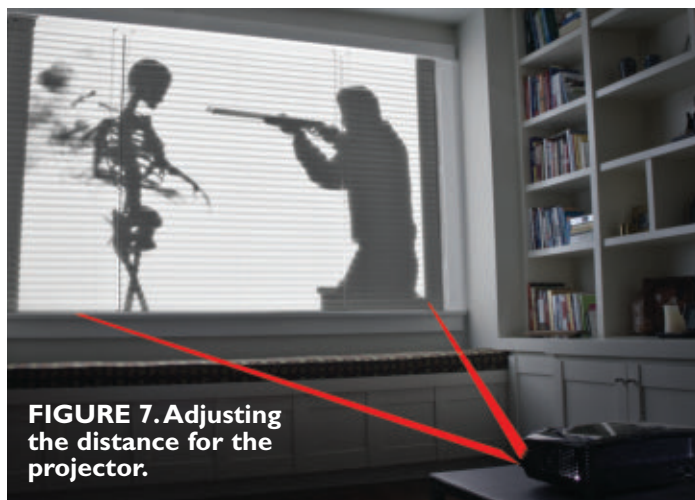


FIGURE 7. Adjusting the distance for the projector.

spooks that will appear out of the darkness. I took video of how the effect looks in my upstairs window (see **Resources**).

One upside to using small projectors is that they are easily hidden and can be mounted in places where people won't notice them. These small projectors can be put inside a pumpkin or behind a tombstone. When coupled with a great digital decoration and a little imagination, you can create some really neat Halloween props that people will be sure to talk about.

Last year, I came across a few videos of people using

RESOURCES

Video of my upstairs Halloween window projections from 2013
<http://youtu.be/5GPjboEDS20>

Really awesome projector for home and yard haunts
www.youtube.com/watch?v=RDJJMHgqyRg

Eerie Acres Cemetery YouTube Channel
www.youtube.com/channel/UCsJHc00LiEm8p1NUjbzLqQ

Eerie Acres website
www.eerieacrescemetery.com/

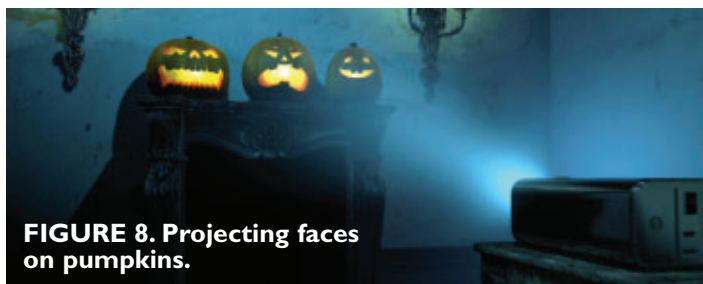


FIGURE 8. Projecting faces on pumpkins.

projectors to do singing pumpkin displays and decided I had to do one too (**Figure 8**). One of the biggest components I had in mind to making my singing pumpkin display was to hide the projector in such a way that people wouldn't know how the illusion was done.

Thanks to its small size, I was able to easily hide one of my projectors in a headstone that I created. The headstone not only hid the small projector, but also hid my PC speakers and media player. People loved it!

All night long, people constantly asked me how I achieved the singing pumpkins, and each time I told them there was a projector hidden in the headstone directly in front of them they were amazed.

You can see the singing pumpkins in action, along with a detailed overview of the projector and headstone in the video at www.youtube.com/watch?v=in10rFK8Rt4.

There are numerous applications that these small projectors are perfect for. Create a wall full of scurrying insects at your next Halloween party, put a ghost at the end of a dark hallway, or even recreate the famous head of Madame Leota from Disney's Haunted Mansion using a fishbowl with a blank white Styrofoam head in it.

Thanks to the recent affordability of projectors, media players, and new digital decorations being created each year, there is no limit to the fun that can be had! Happy Haunting! **NV**

Post comments on this article at www.nutsvolts.com/index.php?/magazine/article/october2014_Petrone.

Don't forget you can apply this technique to other holidays, birthdays, weddings ... any kind of special event.

ALL ELECTRONICS

www.allelectronics.com

Order Toll Free 1-800-826-5432

128 X 64 GRAPHIC LCD

Seiko # G1226B1J. Led back light. Module size: 3.67" x 2.76" x 0.42" high. Built-in RAM. Wide viewing angle and high contrast. Slim, light weight and low power consumption.

CAT# LCD-12864



\$9.00
each

12VDC 2A POWER SUPPLY

OnCue #W12-024N1A. Features "piggy-back" AC outlet enabling another two-prong AC device to plug in on top of power supply. 5' cord with 1.3mm coax power plug, center+. cULus.

CAT# PS-1112



\$9.25
each

1-POLE, 7-POSITION ROTARY SWITCH

ALPS# SRBV170501. 7 position, 1-pole low profile vertical type non-shorting rotary switch. Resistive load 0.3A 16 Vdc / 50ua 3 Vdc. Changeover angle 30°. 6mm x 20mm flat shaft. Threaded bushing, M9 x 0.75. PC pins & mounting tabs for additional support.

CAT# RSW-36



\$2.50
each

30 DETENT ROTARY ENCODER WITH SWITCH

Alps mechanical rotary encoder with momentary-on push switch. 30 detents. 6mm dia. aluminum shaft. 12mm square body. 7mm dia. x 10mm high plain bushing. PC pins. CAT# RE-30



\$1.35
each

50 for \$1.15 each

12 VDC 45A, 3.3 VDC 3A POWER SUPPLY

Astec #DS550-3 550W network power supply. Designed as a hot-pluggable supply, but can be used as a stand-alone with a little modification. Overall dimensions, 13.29" x 3.07" x 1.52". UL/ cUL, CE. Power cord not included.

CAT# PS-2545

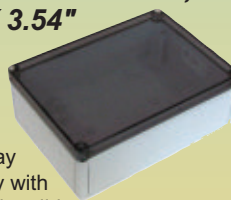


10 for \$20.00 each

\$23.95
each

POLYCARBONATE INDUSTRIAL ENCLOSURE, 10" X 7.09" X 3.54"

Altech 130-008 by Spelsberg TK series. Insulated and corrosion free enclosure. Light gray polycarbonate body with smoky transparent box lid. Polyurethane gasket provides protection from dust and water. Plastic standoffs and knock-out mounting holes on back panel. Plastic hardware to fasten lid included. Wall mount. 254 x 180 x 90mm. cULus.



CAT# MB-135

8 for \$22.50 each

\$24.50
each

HALL EFFECT SENSOR

MICRONAS HAL115UA-C. Bi-polar. Detects the presence or the absence of a magnetic field.

CAT# HES-1

75¢
each



10 for 65¢ each • 100 for 55¢ each

HALLOWEEN & HAUNTED HOUSE CONVENTION



**OPEN TO THE PUBLIC
DEALER ROOM
MAKEUP DEMOS
COSTUME BALL
PROP BUILDING WORKSHOPS
BACK STAGE HAUNT TOURS**

February 7-10, 2015

BELLE OF BATON ROUGE HOTEL & CONFERENCE CENTER
BATON ROUGE, LA

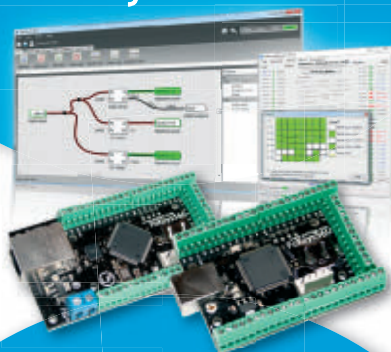


Details: Call 972-951-5100 or visit
WWW.HAUNTCON.COM

Imagine this...

- a small and inexpensive
- USB or ethernet device
- with a rich set of features
- including PLC functionality and up to 8-axis stepper motor controller
- all accessible via free .NET, ActiveX or C++ library
- cross-platform
- configurable with free software

PoKeys



Or this...

- all in one: Oscilloscope, Data Recorder, Logic analyzer, Analog and digital signal generator
- smallest USB 2.0 portable 1MS/s oscilloscope
- data acquisition of analog and digital signals
- data recording
- export to CSV, XLS, PDF and HTML
- simple usage of advanced features
- examples for C++, VB, Delphi and LabView
- free software and updates

PoScope Mega1+



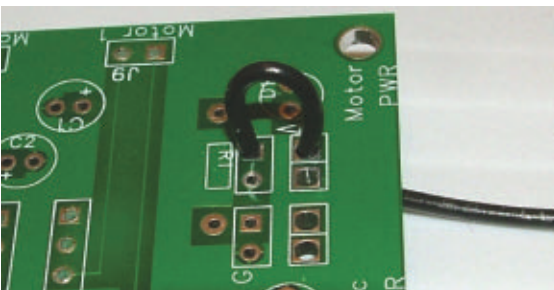
Polabs



Visit us at
www.poscope.com

Wiring and Testing the BalloonSat Extreme Flight Computer

Last time, we built the BalloonSat Extreme — an advanced BalloonSat flight computer based on a BASIC Stamp 2pe (BS2pe). Because of the BS2pe's memory banks, the BalloonSat Extreme lends itself extremely (get it?) well to modeling the integration of experiments into a single payload. I believe this process of experiment integration is a good activity for students as it simulates the work of scientists integrating their experiments into a single JPL spacecraft.



■ **FIGURE 1.** This is how to solder wires to a PCB using strain relief. Pull the loop out of the wire after it's soldered to the board, but not so tightly that the wire's soldered connection is stressed.

Wiring

There are a total of seven cables (for a total of 14 wires) in the flight computer. With the PCB (printed circuit board) turned so that the wires exit the top of the board, the wire pairs from left to right are: servo power indicator; servo power switch; servo battery; commit; main battery; main power switch; and main power indicator.

You may wonder why the BalloonSat Extreme uses separate batteries for the servo and main power. It's because servos can draw a lot of current when stalled or under load, and we don't want a distressed servo drawing so much current that it causes the BASIC Stamp to "brown out" (an unintentional drop in voltage that causes the Stamp to reset and begin executing its code from the beginning). A much more graceful failure mode is to have the servos fail to function properly without harming the operation of the flight program.

The wires are protected from breaking off by passing them through strain relief holes in the PCB. I'm a big proponent of strain relief; I've seen too many wires break in my student's soldering projects. It's important to protect wires because if they break during a mission, the experiments are likely to fail. All that money spent and no data returned.

Figure 1 shows an image of a wire incorporating strain relief. Notice that the wire passes through a larger diameter

hole located at the edge of the PCB before it's soldered to the board.

I recommend cutting the wires for the power switches, power indicators, and commit one foot long. For the main power, you can use a six volt four "AA" cell holder or a 7.2V rechargeable lithium polymer (LiPo) battery. Since servos work on 4.5 volts, you can use a three "AA" cell holder for servo power.

If you decide to use cell holders rather than LiPo batteries, then solder the battery holder's wires to the PCB. If you opt to use LiPo batteries instead, then solder one foot long wires for main and servo power, and terminate them with the appropriate connector for the battery pack. I have found that rechargeable R/C car LiPo batteries work well for near space missions.

After soldering all 14 wires to the PCB, strip the opposite ends of the power switch, power indicator, and commit wires. Solder sub-mini toggle switches to the power switch wires and LEDs to the power indicator wires. Be sure to slide heat shrink tubing over the wires prior to soldering the switches and LEDs.

The last wiring step is the termination of the commit pin wires. A method I recommend is to solder the commit wires to the tabs of a female sub-mini (3/32") mono jack panel mount. The commit pin is a male sub-mini mono jack with its tabs shorted together with a short length of wire. Refer to **Figure 2**. When the commit pin is plugged into the panel mount, commit is shorted out and the Stamp detects a logic low. When the commit pin is removed, the short in the commit is removed and the

Post comments on this article and find any associated files and/or downloads at www.nutsvolts.com/index.php?/magazine/article/october2014_NearSpace.

Stamp detects a logic high.

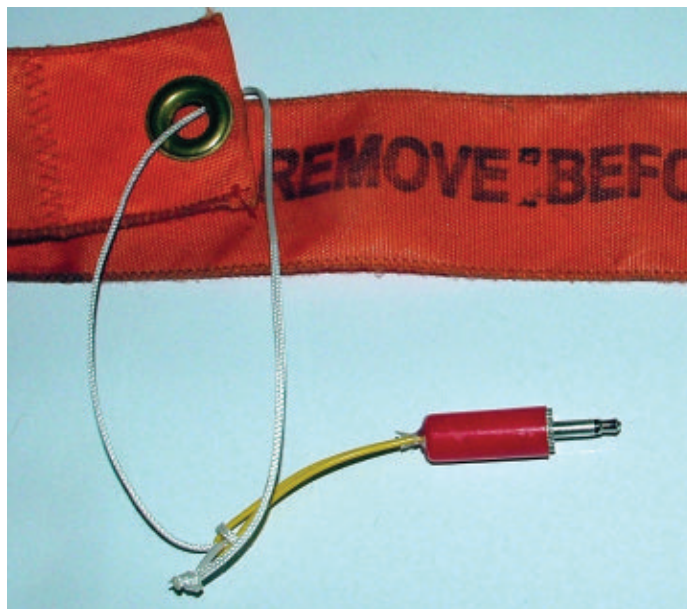
Mount the power switches, power LEDs, and commit panel mount to a stiff sheet of plastic. The arrangement should be logical, so place the switch and LED for main power next to each other, and the switch and LEDs for servos next to each other. Place the commit panel mount in the middle or off to one side. The plastic panel is mounted into the airframe of the near spacecraft during its construction. This gives the launch crew easy access to the power and launch functions of the craft. There's no need to open up it just to power-up and launch.

Testing

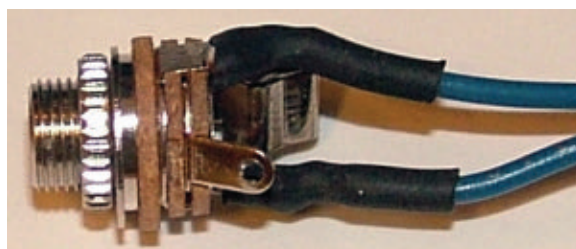
Now that construction is complete, it's time to test the assembly. Therefore, don't install the Stamp or connect the battery at this time. The first two tests must be done without a battery since it's harmful to a digital multimeter (DMM) to measure either resistance or continuity while the circuit is live (powered up). The first two tests are designed to verify there's no short in the flight computer and that it's safe to insert the Stamp. While it's very likely your flight computer has been constructed properly, it's a good idea to wait until you have proof before inserting the microcontroller.

First, inspect the bottom of the PCB and make sure there are no shorted connections. This happens if solder overflows its pad or if a PCB trace was poorly made. After the visual inspection, it's time to start the electrical tests.

The second half of the first test is to measure the resistance between



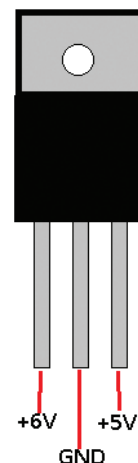
■ **FIGURE 2.** A mono jack and its panel mount used for the commit pin. Note that I have attached a red ribbon to the shorting wire in the jack. This way, it is difficult to miss. For additional strength, I filled the interior volume of the jack screw-on cover with hot glue.



■ **FIGURE 2A.**

the positive and negative terminals of the battery connections. Set the DMM to "continuity check" and verify there is no short between power and ground. Do the same for the servo power. Make one more continuity check by measuring the resistance between pins 4 and 21 of the Stamp IC socket. Again, there should be no shorts. Only after passing these two tests is it safe to connect batteries to the flight computer.

The second test is the voltage test. So, set the DMM to measure voltage (if the DMM is not auto-ranging, set it to the 20 volt scale). Now, throw the main power switch



■ **FIGURE 3.** If your BalloonSat Extreme appears to be acting up, use this diagram when measuring the voltage of the voltage regulator.

and verify that the LED illuminates. With the DMM, measure the voltage between pins 4 and 21 on the Stamp socket (where pin 4 is ground and pin 21 is +5 volts). The DMM reading should be between 4.75V and 5.25V.

If not, look for a bad solder connection or an incorrectly soldered voltage regulator. If the LM2940 voltage regulator feels hot or if the output voltage is wrong, then shut off the power switch immediately and look for a short, broken connection, or incorrectly installed voltage regulator. **Figure 3** is a diagram of the voltages expected on each lead of the voltage regulator (assuming a 6V battery pack).

There's one last set of tests to make on your BalloonSat Extreme for the servo power. Repeat the same tests as you did for the main power. Make sure there's no short between the positive and negative leads of the servo power battery pack with a continuity test. Then, insert the batteries and flip on the servo power switch. The servo power LED should illuminate. Now, measure the voltage

Near Spacecraft Mission Proposals

I've been giving some thought to how students should propose an experiment for a BalloonSat Extreme mission. First, the students need to know that a near space mission is being planned and they can propose meaningful experiments for it. The limitations of the near spacecraft have to be clearly spelled out, so students can intelligently plan an experiment for the flight and write a proposal advocating its acceptance.

Each student proposal must clearly define the purpose of the experiment and its requirements. That reduces the chances of redundant experiments, an overweight near spacecraft, or an over-taxed flight computer. In addition, each proposal should explain how the student experiment will be designed, built, and tested to meet the timeline of the launch. That way, the flight is not held up by a slow experiment.

After evaluating all the proposals, the best are selected and the students are given the deadline to deliver whatever is going up on the balloon. So, here's what I believe the process should look like, based on a simplified version of what I understand is used in science and industry.

Request for Proposal (RFP)

The RFP describes the proposed near spacecraft mission and the near spacecraft's limitations. After reading the RFP, students should understand enough about the near spacecraft to design a suitable experiment. So, here's an example:

The proposed mission is expected to reach an altitude of 90,000 feet during a 90 minute ascent which is then to be followed by a parachute descent lasting 45 minutes. The balloon burst and initial descent is traumatic and experiments can expect to experience forces across a range of gs in multiple directions and over very short time scales. The near spacecraft's flight computer is limited to eight analog ports, five digital ports, three servo ports, and one GPS port. All signals are limited to five volts. Up to 0.5 amps of five volts is available to power all the experiments. Each experiment can expect up to three I/O connections to the flight computer through the use of three-pin headers with 0.025 inch wide square leads and 0.1 inch lead spacing. The header is configured such that the pins are designated as ground, +5V, and I/O. Experiments can store 2,048 records in either one byte or one word data records. The near spacecraft is limited to six pounds of total weight, including its flight batteries and airframe. The volume is not restricted. A portion of each

experiment can reside outside the near space vehicle and will be attached to the airframe (made from 1/2 inch thick Styrofoam) using #6-32 bolts, nuts, and fender washers. Experiments can be extended away from the airframe using lightweight booms of Styrofoam and/or Syntra (foamed PVC).

The Experiment Proposal

Here's what I propose each student team provide to the mission design. This should be enough information for the near spacecraft designer to lay out the near space vehicle, calculate total weights, and assign I/O and memory to experiments. Students should be given a blank document to fill in with this information so they don't leave anything out:

- Name of the experiment
- Purpose of the experiment
- Theory behind the experiment (why does it work)
- Weight of the experiment
- Volume of the experiment (interior and exterior portions of the experiment)
- Structure of the data (words or bytes)
- Number of servos
- Number of analog channels
- Number of digital channels
- Whether GPS data is required (and which fields)
- A budget that includes money to purchase parts, and time to assemble and test
- Sketch of the experiment showing its dimensions
- Past experience showing the team can complete this experiment on time
- Procedures used to verify the experiment will operate for the duration of the mission
- Outline of program used to verify that the experiment is working properly
- Outline of the flight code

Acceptance and Deliverables

After having their experiment accepted, I would encourage students to produce more than one copy of their experiment. One copy would be the flight article, and I recommend that it be the last one they assemble. The prior experiments are test articles and they give students the opportunity to refine their design, assembly, and testing. Student teams must document their construction and testing. They must also document how well the experiment meets its requirements. Upon delivery, the experiment must be complete — no last minute fixes are allowed. The delivery of the flight article must also include the tested subroutine used to operate the experiment and collect its data.

So, what do you think? I invite *N&V* readers to contact me with their ideas for this proposal process.

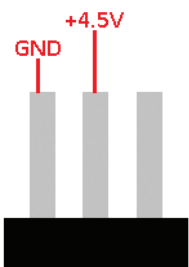


FIGURE 4. The standard arrangement of pins in a servo connection looks like this.

across the servo port. As illustrated in **Figure 4**, the outer pins of the servo port are ground and the middle pins are 4.5 volts (assuming your flight computer is using a 4.5 volt supply for the servos).

So far so good? Next time, I'll explain all the code you need to operate a BalloonSat Extreme mission. Remember, the goal of this flight computer is to create a

platform for advanced students where they practice integrating their experiments into a single near space vehicle — just like scientists do for the JPL space vehicles. So, the code for the BalloonSat Extreme uses lots of subroutines designed for each particular experiment.

Onwards and Upwards,
Your near space guide **NV**

cathode displays are now available, but cost quite a bit more. The smaller displays are very affordable. It would be ideal to make available a PCB for the project, a programmed chip, and a crystal for the time base. Most DIYers would have the other parts needed. The PCB could be made small so that builders could use a variety of case sizes depending on the size of the displays used. It wouldn't hold the displays themselves; the builder would mount them as needed. For my old clocks, I mounted the 4" and 2" displays on a thin sheet of plywood painted black in a case made from pieces of acrylic I got at Tap Plastics.

Jack Rubeck

Thanks for the feedback. We have the same definition of "big" — I've used Futurlec displays and other large digits in my clocks. I'm familiar with 73 and Nixie displays, as well. I'm sure we share quite a few experiences. Again, thanks and — I assume — 73s.

Bryan Bergeron

The gauntlet has been thrown! If you're interested in taking a crack at this project, email VernGraner@nutsvolts.com.

Can't Get Swing of Math

Regarding the parameter amplifier article in the June 2014 issue, I haven't gotten the frequency of a simple pendulum to equal 1.5 Hz using Richard Panosh's equation with the numbers in the article. I put the numbers into Excel and it is 10 times under the 1.5 Hz. I checked my numbers with XLC and it will draw the correct equation.

James Thompson II

Sorry to hear you're having trouble with the expression for the frequency of this simple pendulum.

Take the free length of the string as four inches long. Add the radius of the ball to this to obtain the total length to the center of mass:

4 inches + 1/2 (3/4 inch ball diameter) = 4.375 inches

4.375 inches x 1 ft/12 inches = 0.36 ft

$$f = \frac{1}{2\pi} \sqrt{\frac{g}{l}}$$

$$f = \frac{1}{2\pi} \sqrt{\frac{32.2}{0.36}} = \frac{1}{2\pi} \sqrt{89.444} = \frac{9.46}{2\pi} = 1.5$$

Hope this clears up the issue. Thanks for your interest and good luck in your studies.

Richard Panosh

ARLCD 3.5-inch Arduino GPU Combo Just \$99.00



Product Specifications: 3.5" color TFT LCD • 320 x 240 Resolution • 65k colors • Touchscreen • Powerful 16-bit microcontroller GPU • 4MB flash memory for storing fonts, bitmaps & macros • USB 2.0 • Overall outline dimensions: 3 x 3 x .9 inches • 6-9V operating voltage • Extremely low power - draws less than 200mA • ARLCD Arduino GUI Library • Arduino UNO R3 Compatible



Feedback Motion Control

The Old Way

- 1) Build robot
- 2) Guess PID coefficients
- 3) Test
 - 3a) Express disappointment
 - 3b) Search Internet, modify PID values
 - 3c) Read book, modify PID coefficients again
 - 3d) Decide performance is good enough
 - 3e) Realize it isn't
 - 3f) See if anyone just sells a giant servo
 - 3g) Express disappointment
 - 3h) Re-guess PID coefficients
 - 3i) Switch processor
 - 3j) Dust off old Differential Equations book
 - 3k) Remember why the book was so dusty
 - 3l) Calculate new, wildly different PID coefficients
 - 3m) Invent new, wildly different swear words
 - 3n) Research fuzzy logic
 - 3o) Now it is certainly not working in uncertain ways
 - 3p) Pull hair
 - 3q) Switch controller
 - 3r) Re-guess PID coefficients
 - 3s) Switch programming language
 - 3t) Start a new project that doesn't need feedback control
 - 3u) See parts in box. Feel guilty. Go back to old project
 - 3v) Start testing every possible combination of PID coefficients
 - 3w) Apply eye drops to red, bloated, sleep-deprived eyes
 - 3x) Wait, it's working!
 - 3y) Decide not to do any more projects that require control systems
 - 3z) Wonder why someone doesn't just make a thing that tunes itself

The Kangaroo x2 Way

- 1) Build robot
- 2) Press Autotune
- 3) Get a snack

Kangaroo x2 adds self-tuning feedback to SyRen and Sabertooth motor drivers.



\$24.99



www.dimensionengineering.com/kangaroo

Building a ZigBee HAN

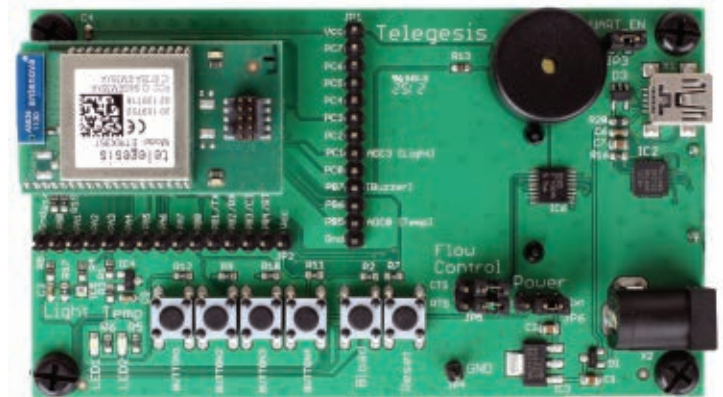
ZigBee was originally designed as a lightweight network. The idea was to be able to send small packets of data over limited distances. Thus, ZigBee was aimed at low data rate sensor networks and industrial control applications. It seems that everything these days that finds its way to the Internet and ZigBee is no exception. Today, remote ZigBee networks can be easily monitored and administered via an Internet connection. In this installment of Design Cycle, we will explore the use of the Internet to propagate ZigBee monitor and control data. Instead of focusing on relatively complex industrial sensor applications, we will go "home" and perform some home automation-based data exchanges over the Internet.

What are We Trying to Do??

Our goal is to assemble a two-node PAN (Personal Area Network) that is, in reality, a HAN (Home Automation Network). Our PAN will consist of a single FFD (Full Function Device) node that will be under the control of a PAN Coordinator. Once we get the PAN online, the next step will be to contact the Coordinator via an Internet-routed Telnet connection. This particular "home-based" PAN will be logically considered "remote" as we will only access the PAN via an Internet connection. If all works as designed, we will be able to query and control the devices attached to the remote FFD node. We will also be able to interact in a remote manner with the PAN Coordinator.

The HAN FFD

The FFD HA device you see in **Photo 1** is hosted by a Telegesis ETRX357 ZigBee radio module that is loaded



■ **Photo 1.** This piece of hardware is part of the Telegesis HA evaluation kit. It is equipped with a temperature sensor, a light sensor, some LEDs, and a buzzer. Our goal is to access all of these goodies from a Telnet session running over the Internet.

with a ZigBee PRO stack and custom HA firmware. This custom firmware was seeded from the ZigBee Home Automation Public Profile. Access to the HA profile is provided by Hayes-like AT commands which result in easier HA application development. The AT command set is universally recognized and easy to use. In this case, the AT commands provide a simple user and application interface to the complexities of the ZigBee stack.

Telegesis Five-In-One firmware is loaded on the FFD data radio. The FFD endpoint firmware has the capability of servicing a maximum of five monitor and control functions using a single ETRX357 radio. As you can see in

ENDPOINT	DEVICE NAME	DEVICE ID
0x01	ON/OFF OUTPUT	0x0002
0x02	LEVEL CONTROLLABLE OUTPUT	0x0003
0x03	LIGHT SENSOR	0x0106
0x04	TEMPERATURE SENSOR	0x0302
0x05	ON/OFF SWITCH	0x0000

FIVE-IN-ONE DEVICE ENDPOINTS

■ **Figure 1.** The devices native to the Five-In-One HA device you see in Photo 1 can be accessed using these Endpoint and Device ID combinations.

Post comments on this article and find any associated files and/or downloads at www.nutsvolts.com/index.php?/magazine/article/october2014_DesignCycle.

Figure 1, one pair of the five endpoints performs light on/off and light dimmer functions. Onboard FFD sensors provide temperature and luminance data (lower left corner of **Photo 1**).

There is also a fifth on/off switch function. The five endpoints are accessed with AT commands that originate at the Combined Interface (CI) device which is also a specially prepared Telegesis ETRX357 radio module. The CI firmware runs on an ETRX357 module that needs to be active at all times. Thus, the CI is powered from a permanent power source. The FFD nodes can sleep while the CI stands watch. This allows the FFD devices to be permanently powered or battery powered, depending on the needs of the application.

The HAN CI

That little black box under the lights in **Photo 2** is actually a Telegesis ZigBee Communications Gateway. Yes, I was tempted to show it to you with its clothes off. However, we really don't need to know what's going on inside. We simply need to know how to use what's inside.

The ZigBee Communications Gateway has printed circuit board (PCB) space for two Combined Interface Control and Indicating Equipment (CICIE) friendly ETRX357 radios. The Communications Gateway we have in our possession contains a single Telegesis ETRX357 CICIE capable radio module which is configured to operate in CI mode.

The ZigBee Gateway is truly a "black box." The outside world only sees a single RJ-45 Ethernet jack, a USB portal, and two exposed switches. Configuration of the Gateway is performed using a web browser to interact with the web pages that are served by it. Power for the Communications Gateway is obtained from the USB portal. The trio of switches performs reset functions and user-selected message transmission via pushbuttons and a paper clip. ZigBee connection and Ethernet link status are conveyed via a quintet of LEDs. The status LED patterns can be seen in **Figure 2**. It's rather obvious that green and amber are good operational colors.

Configuring the Telegesis ZigBee Communications Gateway

The ZigBee Gateway implements the UPnP discovery service. This means that with Windows 7 and 8, we can see the Gateway by simply viewing the network infrastructure. All we have to do to get to the Gateway web pages is right-click on the entry as shown in **Screenshot 1**. You can also gain access to the Gateway's web pages via a standard web browser. To do this, you will need to know the current IP address.

I used the MAC address printed on the bottom of the Gateway and my router's device list to get the current IP



■ **Photo 2.** This very simple looking device sports an Ethernet jack, a USB portal, and three switches.

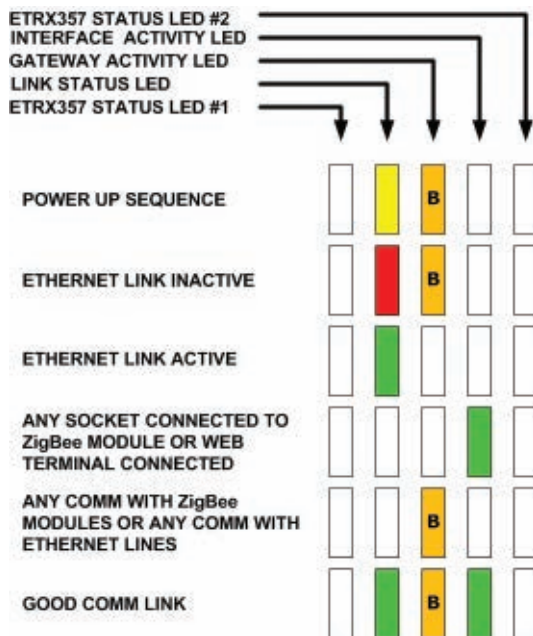


■ **Screenshot 1.** You can also get to the ZigBee Communications Gateway's web pages using a standard web browser once you know the Gateway's IP address.

■ **Screenshot 2.** When all else fails, the LAN router is the go-to guy. If you know the device's MAC address and the device has contacted the router via DHCP, you can deduce the device's IP address.



address of the Gateway. The MAC or hardware address is 00:21:ED:20:04:8F, which I matched up to the router entry in **Screenshot 2**. Thanks to DHCP being enabled by default in the Gateway configuration, I can be sure to get an IP address if it has joined the LAN. Now that I have an IP address, I can use Firefox to gain local access to the ZigBee Gateway web page.



■ Figure 2. The ideal situation is an amber blinking LED snuggled between green LEDs.



■ Screenshot 4. This is a view of the ZigBee Communications Gateway's Configuration web page. These values have nothing whatsoever to do with the ZigBee module configuration.

Once the bits and status LEDs align (green-amber-green in **Figure 2**), **Screenshot 3** appears. Since we will be accessing the Communications Gateway using an Internet connection, we will need to configure a static IP address

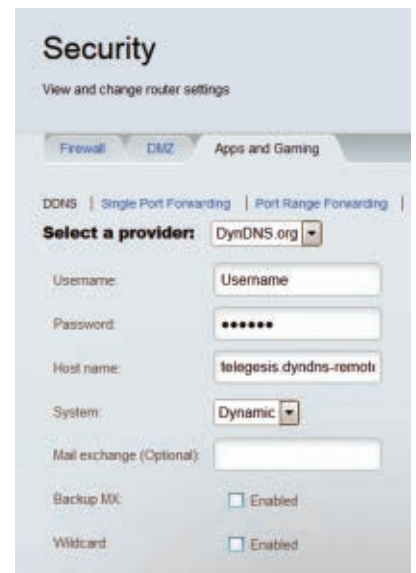
echo	0	7000	Both	192.168.0.137	True	Edit Delete
PIC32MXServer	9000	9000	Both	192.168.0.125	True	Edit Delete
Telegesis Gateway	8800	8800	Both	192.168.0.97	True	Edit Delete

■ Screenshot 5. The router has been configured to allow traffic to pass to and from the 192.168.0.97:8800 socket interface.



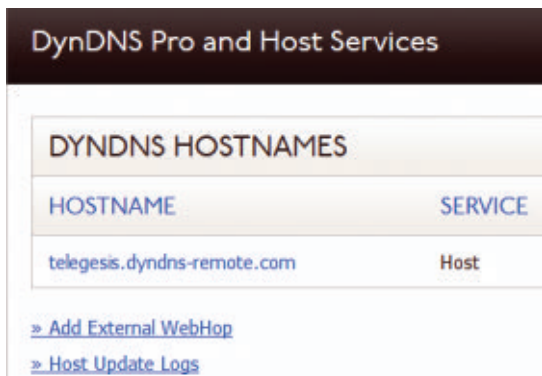
■ Screenshot 3. Note the default Static IP Configuration and Dialin TCP Sockets Configuration values. We will deal with them later. The important thing right now is that DHCP is enabled by default and we can view this web page.

■ Screenshot 6. The dynamic DNS service is much cheaper than leasing a static IP from an ISP. The DynDNS service keeps track of the LAN router's Internet-facing IP address, which is constantly being changed by the ISP.



and assign our desired Dialin TCP socket port. These adjusted configuration values must match the configuration values that exist in the router that is serving the Gateway.

I've decided to assign the ZigBee Gateway a static IP address of 192.168.0.97 with a port number of 8800. Scanning **Screenshot 4** reveals the disabling of DHCP and defining the LAN default Gateway IP address in addition to assigning the TCP socket values (192.168.0.97:8800). For this magic to work, we must also configure the LAN



■ Screenshot 7. Once the LAN router has been configured to recognize the dynamic DNS service, we simply create and activate an associated host on the DynDNS site.

router to allow traffic to pass over our newly configured socket to the Gateway. You can see how this is done in **Screenshot 5**.

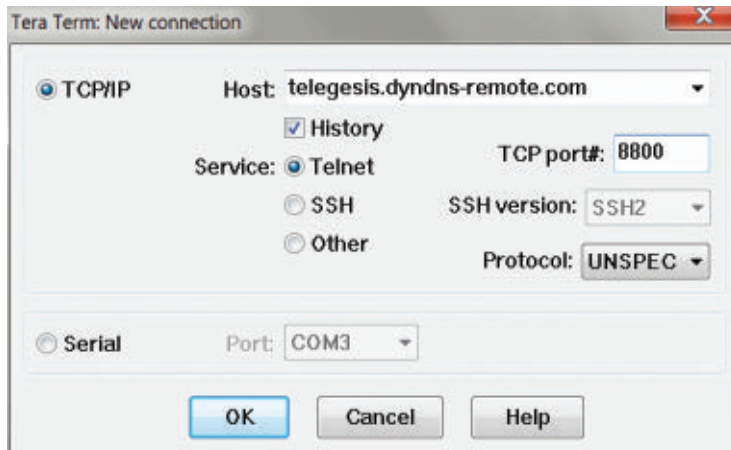
We're not done with the LAN router. Normally, the ISP (Internet Service Provider) will frequently change the IP address it assigns to the router. So, we can't hard configure the router's IP address as it is subject to change. We could lease a static IP address from the ISP, but that is expensive. The alternative is to use what I consider one of the best Internet tools available: the DynDNS service. I've set up a DynDNS host on the router in **Screenshot 6** called *telegesis.dyndns-remote.com*. The link isn't complete until I create and activate an identical host on the DynDNS website. **Screenshot 7** tells that tale.

At this point, everything should be in place. The Gateway is configured to be contacted from a LAN or Internet connection. If all works as designed, we should be able to Telnet into the ZigBee Communications Gateway and gain access to the PAN on the other side of the Gateway.

Heating Up the HA PAN (HAN)

There are multiple ways to bring up our HA PAN (HAN). We can choose to bring it to life locally or we can configure the HA Five-In-One device to join a particular HA PAN when it becomes available. Let's keep this simple and initiate the birth of our HAN locally. However, instead of doing it this way, we will breathe life into it over the Internet.

As it stands right now, the Communications Gateway is physically and logically connected to a LAN. It is listening behind the socket 192.168.0.97:8800. There are no active HANs. The objective is to contact the Gateway by way of a Telnet session which we will initiate with Tera Term Pro. **Screenshot 8** is our ticket in and eventually to its HAN.



■ Screenshot 8. We are ready to make first contact via Tera Term Pro. Note that our host name is pointing to the host we created on the DynDNS website.

Kicking off the Tera Term Pro session bore fruit in **Screenshot 9**. The initial AT was answered by the Gateway with an OK. Things are looking real good at this point, so I decided to query the Communications Gateway. It replied with the internally mounted data radio type, the data radio firmware version, and the data radio's 64-bit EUI

RF Specialists

"Making your RF ideas into profitable products."

Amateur Radio HAM Bands

High Altitude Balloon Research Applications

VHF Narrow Band FM High Power (300mW) Transmitter

Additional Applications:

- Automatic Position Reporting System (APRS)
- Asset Tracking and Tracing
- Meter reading systems



Long Range Remote Control Applications

Radio Control (R/C) Radio Service under FCC Part 95 subpart C

10kHz channel - operates on the license exempt 27MHz SRD HF allocation

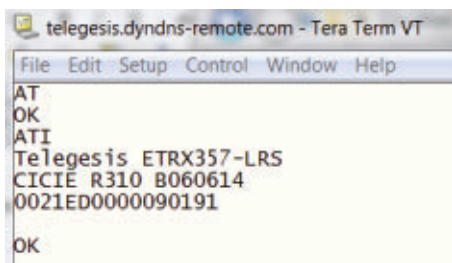



Additional Applications:

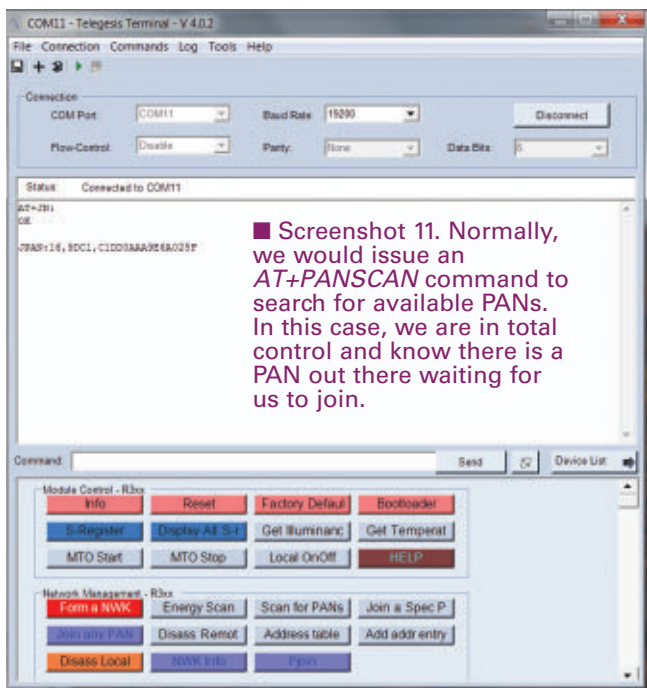
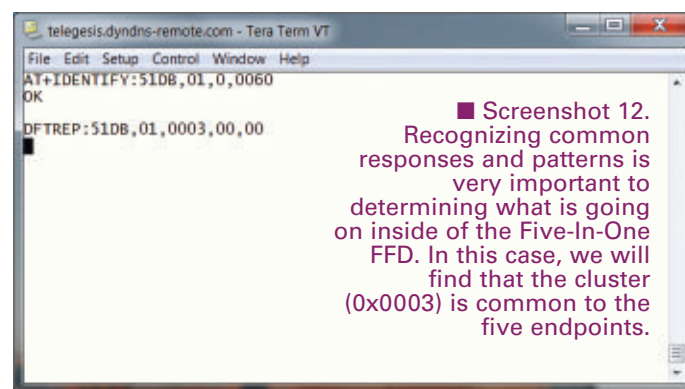
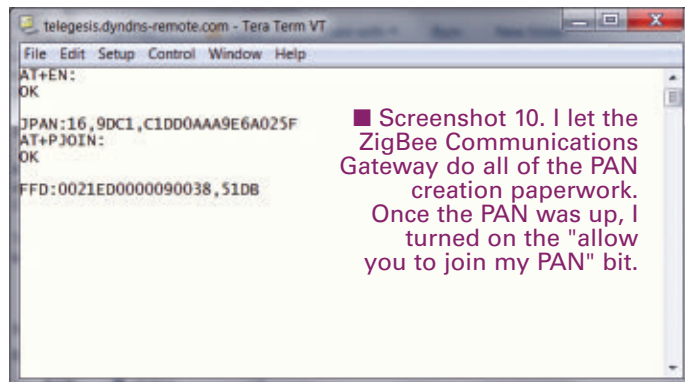
- In-building environmental monitoring and control
- Telemetry and telecommand
- Security and fire alarms
- Vehicle/machinery controls



Tel: 1.866.345.3667
orders@lemosint.com
www.lemosint.com



■ Screenshot 9. We're in! The AT+JRS command forces the ZigBee Communications Gateway to furnish some of its vital ZigBee data radio settings. Here, the radio module is revealed along with the firmware version and the data radio's 64-bit EUI.



which can also be seen in the FFD's response in **Screenshot 10**. We are finally at "home" and we're cooking with gas!

While We're Here

Let's see what we can find out about Node 51DB. From the Telegesis HA documentation and the obvious name, we know our Five-In-One FFD has five endpoints. So, let's send the AT command sequence you see in **Screenshot 12** to query the first endpoint of Node 51DB. The *IDENTIFY* command is aimed at Node 51DB/endpoint 01 for 60 seconds. If the command is issued correctly and is valid at the receiver, a default response (DFTREP) is returned. In this case, the responding node is 51DB and the response emanates from endpoint 01. The associated cluster is 0003. The trailing zeros indicate a valid response.

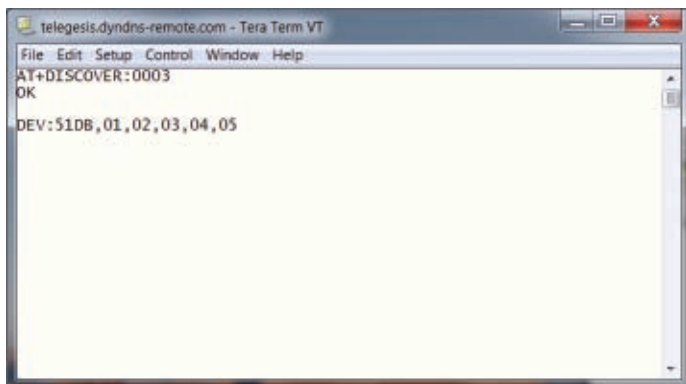
Hmmmm. I issued the same command for all five endpoints and received identical default responses with only the responding endpoint field changed. So, if I didn't already know, I would say that Node 51DB contains five endpoints that associate to cluster 0003. Einstein would try to prove his theory. So will I.

With that, I issued the command sequence you see in **Screenshot 13**. The *DISCOVER* command will query every node in the HAN that has a cluster 0003. In our case, there is only one node in our HAN (51DB). Its default response to our *DISCOVER* query lists five endpoints.

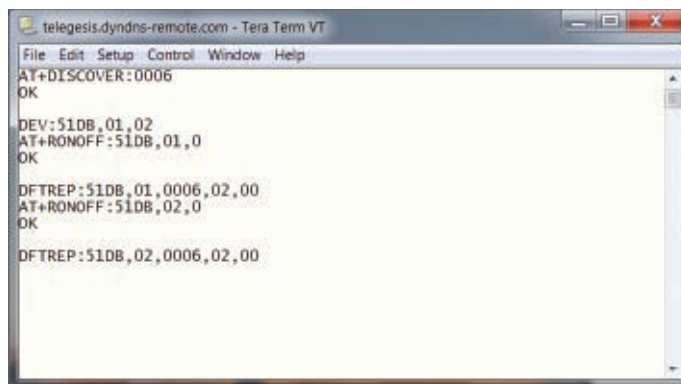
(Extended Unique Identifier).

Okay, it's time to throw the meat into the HAN. I sent the ZigBee Gateway a command to form a new PAN which to our HA nodes will become our new HAN. The official PAN construction orders can be seen in **Screenshot 10**. I took the easy way out and left the PAN creation details up to the data radio firmware. After confirmation that the PAN had been created, I flipped the "you can join my PAN" bit. In the meantime, I attached the FFD node to a Telegesis Terminal session. Knowing that a PAN was already in existence, I simply instructed the FFD node to join the first available one. These orders are displayed in **Screenshot 11**.

Once becoming a member of the ZigBee Communications Gateway's PAN, the Five-In-One FFD is assigned a Node ID (51DB in **Screenshot 10**). The Gateway is also now privy to the new member's EUI,



■ Screenshot 13. Every node that supports a cluster ID of 0x0003 would respond. In that cluster ID, 0x0003 can be found in all of the Five-In-One FFD's function blocks; we can query and receive all of the endpoint information contained in the node.



■ Screenshot 14. Cluster ID 0x0006 represents the ON/OFF cluster. The *AT+RONOFF* command can be used to toggle the target device or — with the addition of an ON/OFF parameter — directly command an ON or OFF state.

RESOURCE

Lemos International

Telegesis ZigBee Communications Gateway
Five-In-One Home Automation Evaluation Kit
ETRX357 ZigBee Radio Module
www.lemosint.com

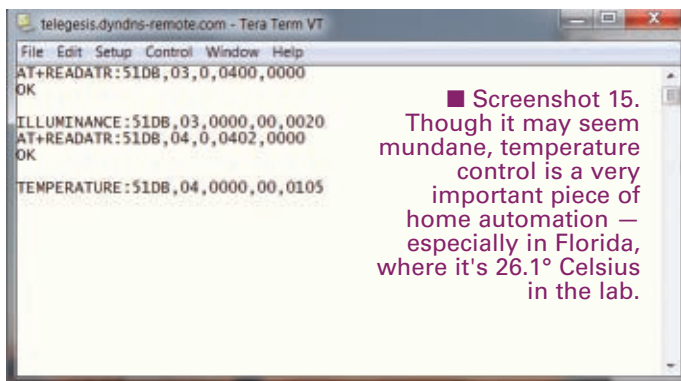
Now I'm dangerous. Consulting the HA documentation, I found that the red and green LEDs on the Five-In-One HA node can be reached via cluster ID 0x0006. According to the documentation, there are two endpoints associated with this cluster. Endpoint 0x01 provides access to the red LED, while endpoint 0x02 is a pathway to the green LED. Naturally, I used *DISCOVER* to verify the endpoints. Then, I used the nifty *AT+RONOFF* command to toggle the LEDs. You can see the command entries in **Screenshot 14**.

The red and green LEDs were extinguished when I issued the commands. As expected, they both illuminated upon the receipt of the default responses. The *AT+RONOFF* command can also be used to direct an ON or OFF state by adding an additional Boolean ON/OFF parameter at the end of the command string.

It's Hot in Here

No way I could have this discussion and not take the room's temperature. Behold **Screenshot 15**. To get the Five-In-One temperature sensor to speak, we issue the *AT+READATR* command. The targeted temperature sensor resides on Node 51DB at endpoint 4. The target cluster ID is 0x402. The returned temperature value is 0x0105. To convert the raw temperature value to Celsius, we simply divide the raw temperature data by 10, which gives us 26.1° Celsius.

While I was in the neighborhood, I decided to take a



■ Screenshot 15. Though it may seem mundane, temperature control is a very important piece of home automation — especially in Florida, where it's 26.1° Celsius in the lab.

light reading. Without fishing out the technical details, all I can tell you is that it's not pitch dark (0x0020 instead of 0x0000) in the lab.

It's Good to Be Home (Automated)

In this discussion, we've looked at the basics of deploying a home automation solution using a Telegesis ZigBee Communications Gateway. The beauty of the Telegesis way lies in the home automation AT command set. Since the AT commands are composed of ASCII characters, the AT commands can be easily incorporated into all of the popular programming languages.

We only fiddled with LEDs in our examples. However, think about this. If you can control an LED, you can control a relay, a motor, shutters, door locks, alarm systems ... get the idea? Now add Internet access to the equation.

Including the Telegesis ZigBee Communications Gateway in your home automation designs makes for an endless home automation Design Cycle. **NV**

ELECTRONET

SKELETONS AND MORE 

Chandeliers Sconces Skeletons Skulls
skeletonsandmore.com

CORIDIUM
Floating point **BASIC** for
ARM controllers from \$5.00
www.coridium.us

USB Add USB to your next project--
It's easier than you might think! 

USB-FIFO • USB-UART • USB/Microcontroller Boards
RFID Readers • Design/Manufacturing Services Available
Absolutely NO driver software development required!
www.dlpdesign.com

HOBBY ENGINEERING
Kits, Parts and Supplies
www.HobbyEngineering.com

 **www.myropcb.com**
PCB, PCBA and More
LOW cost with **HIGH** Quality
1-888-PCB-MYRO

  **velleman Inc.**
3D PRINTER
K8200 www.vellemanusa.com

nte parts direct™ **More Parts. Less Waiting.**
Quality is Always In-Stock

Semi's, caps, resistors, relays, heat shrink and more.

superbrightleds.com
COMPONENT LEDs • LED BULBS • LED ACCENT LIGHTS


\$3 **2 Layers** **ea.**
• FULL DRC CHECK
• CAD/CAM REVIEW
• SOLDER MASK ON BOTH SIDES
Accutrace inc.
www.PCB4u.com
(408) 748-9600


You Can Build This
50 WPC Stereo Power Amplifier Kit

Great sound
Fun to build
Top-notch parts



Detailed assembly manual assures your success.

Find out more and place your order
www.akitika.com

JOYSTICKS
2, 3, & 4 Function
starting at just **\$19.99**
 ServoCity.com

GET THE NUTS&VOLTS DISCOUNT!
Mention or enter coupon code **NVRMZ142**
and receive 10% off your order!

www.ramseykits.com
AM/FM Broadcasters • Hobby Kits
Learning Kits • Test Equipment
...AND LOTS OF NEAT STUFF!

INVEST in your BOT!



INVEST in HITEC
12115 Paine Street • Poway, CA 92064 • 858-748-6948 • www.hitecrd.com

THE ORIGINAL SINCE 1994
PCB-POOL
Beta LAYOUT
• Low Cost PCB prototypes
• Free laser SMT stencil with all Proto orders
WWW.PCB-POOL.COM

ALL ELECTRONICS CORPORATION
Electronic Parts and Supplies.
www.allelectronics.com
Free 96 page catalog 1-800-826-5432


For the ElectroNet
online, go to
www.nutsvolts.com
click **Electro-Net**

The Arduino Classroom

Arduino 101 — Chapter 9: Keeping Time

We have looked at keeping time with computers prior to this Arduino 101 series. Those Workshops were not as novice-friendly as this current series, but they contain a lot of information about computer time that the more curious reader might want to read to get more low-level detail than will be discussed here. The first article was published in the July 2012 issue and it had some general C programming theory plus discussion on a design for a printed circuit board (PCB) with the DS1307 RTC (Real Time Clock), and how to use it with an Arduino. Next, there was a series of articles that greatly expanded on the RTC by building an alarm clock with a C# based PC side application that works in concert with an Arduino proto shield alarm clock. Those articles were published in the January, February, March, and April 2013 magazines. (There are project kits available for these articles from the *Nuts & Volts* webstore.) In this article, we will take a much higher level look at computer time keeping, and learn to use some very novice-friendly applications available for the Arduino.

Keeping Time With the Arduino

Before we begin, let it be known that a raw Arduino isn't all that good at keeping clock time. It may gain or lose several seconds in a day, which is fine for some of the applications we will do later in this series where we record data for no more than a day. If you really need long-term accuracy, then refer back to the aforementioned articles.

Computer Time

In case you didn't know, time began on January 1, 1970. Or, at least Unix time began then, and since that auspicious moment many computers have counted the seconds. As of September 1, 2014 the count is 1,409,529,600, or about one and a half billion seconds. [This factoid is courtesy of www.epochconverter.com/epoch/timestamp-list.php.] That, folks, is one whopping big number! However, it can be stored in a 32-bit integer which is a measly four bytes of data.

The World Will End in 2038

Using Unix time, everything will be just fine — until

2038 when the seconds exceed the capacity of a 32-bit integer and lights out! Sort of like it did in 2012 when the Mayan calendar ended and so did the world. Except, of course, it didn't. The Mayans merely started their calendar over again, or would have if it hadn't been for that conquistador thing.

We can expect the 2038 problem to be much like the Y2K (Year 2000) timekeeping issue that was going to bring the world as we knew it to a screeching halt according to media and other hysterics — only it didn't. It did, however, employ a bunch of programmers for a few years, and the Y2.038K problem will probably do the same.

In the Meantime ...

Unix provided C functions and data types that let folks express those Unix time seconds as more meaningful (to us) units, such as calendar dates and clock times. This can get fairly arcane, and fortunately — like many other complex computing problems — some generous folks have given us an Arduino library — appropriately named Time — that makes things much easier for us. We will install this library in the Arduino directory in Lab X todo.

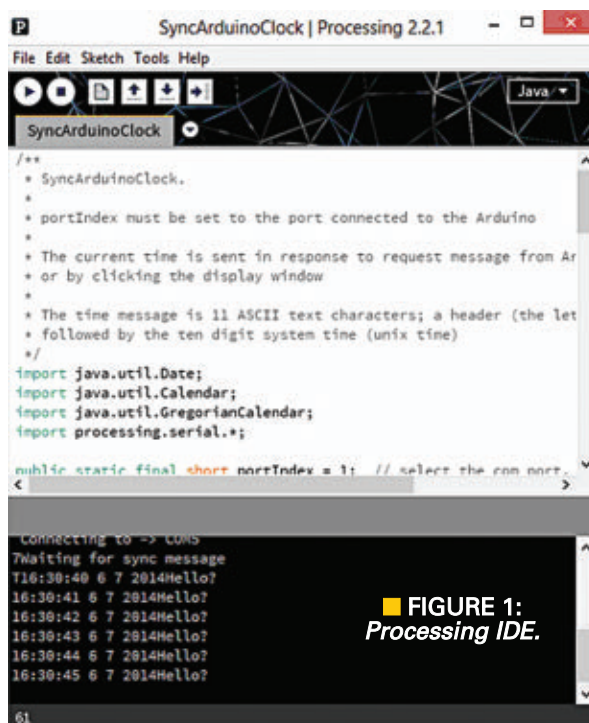
The Time library provides timekeeping functionality

using the Arduino by itself or with external timekeeping devices such as the DS1307 RTC. You can write code to get the time and date as second, minute, hour, day, month, and year, plus it lets us keep time in the earlier mentioned Unix time seconds which is more convenient to handle and store than traditional date and time notations. Also, it lets us set up alarms.

Rather than repeating all the functions here, please refer to <http://playground.arduino.cc/Code/Time>. Don't worry if this seems a bit much. We will only be using a subset of what is available, and we will keep it as simple as possible to fulfill our meager requirements. We will, however, use a brand new program (to us, anyway) that will let us set the time on the Arduino very accurately. This program is called Processing, and as we will see in a moment, it looks kind of familiar.

Processing

The Processing IDE (integrated development environment) is shown in **Figure 1**. Look familiar? It should because the Arduino IDE is built from a version of Processing. You will want to visit processing.org and take a look at all the marvelous things Processing is used for. It was developed initially to provide a simple set of tools so



■ **FIGURE 1:**
Processing IDE.

that artists could use some of the visual effects that were becoming available in Java. Fortunately, since Processing is artist-simple to use and the Arduino IDE is based on it, we won't have to learn much new stuff. In Lab todo, we will use a Processing module provided by the folks that wrote the Time library that lets us use the PC to set the time on the Arduino.

Lab 1: Using the Arduino Time Library

The Time library is not part of the standard Arduino package, so you'll have to download it and set it up yourself. After downloading the library, we will write code to let us set the date and time.

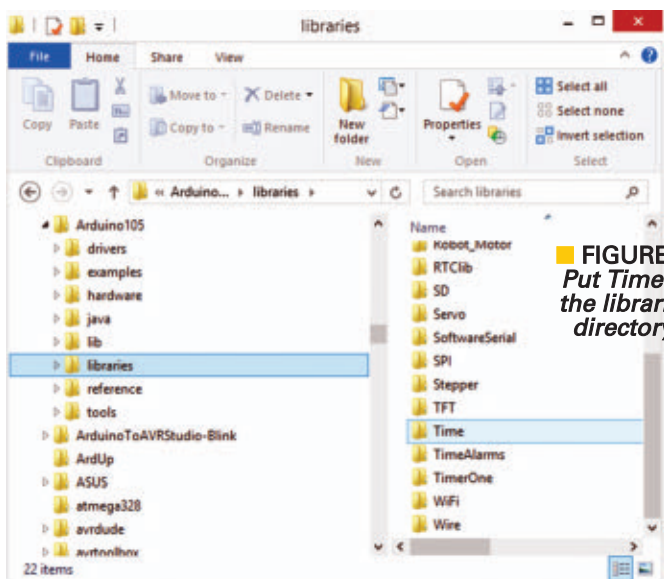
Parts required:

- 1 Arduino
- 1 Computer with Internet connection

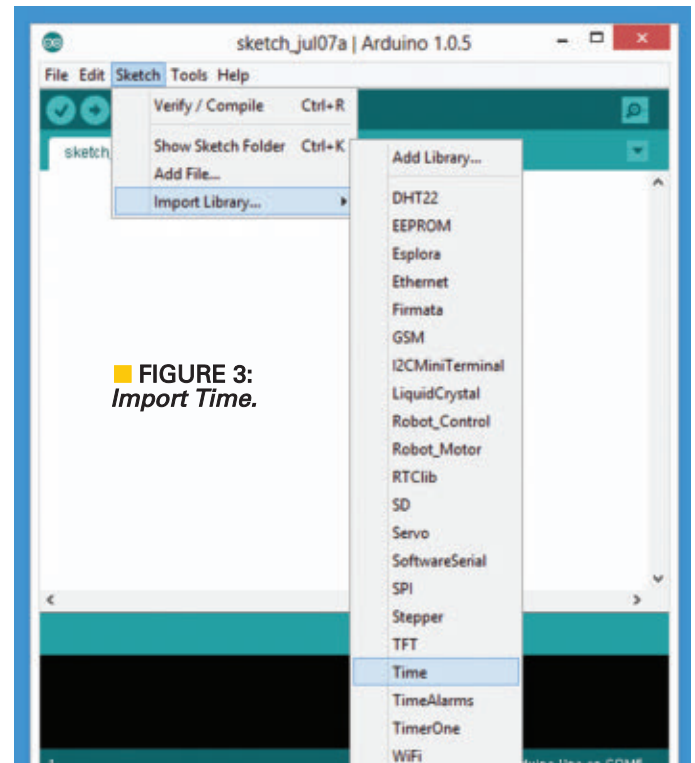
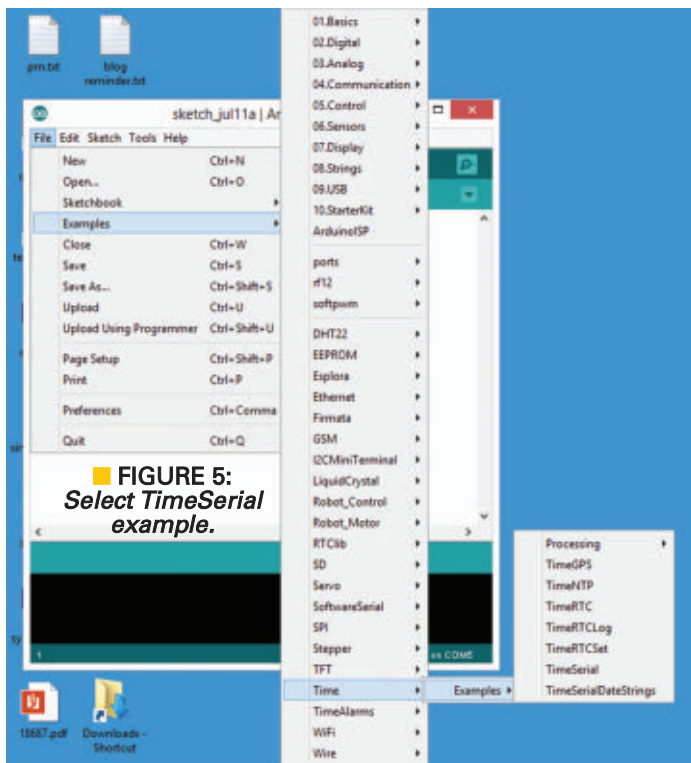
Estimated time for this lab: 20 minutes

Check off when complete:

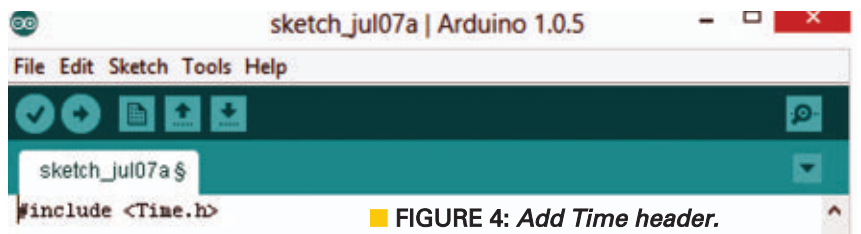
- ☐ You can get the Time.zip file at <http://playground.arduino.cc/Code/Time>. Download this file and unzip it. This will provide a Time directory.
- ☐ Next, find your Arduino directory (usually on drive C: — for instance, I have Arduino 1.0.5 located at C:/Arduino105).
- ☐ Copy the Time directory to the Arduino libraries directory. **Figure 2** shows my Windows Explorer with the file copied to the correct directory. It must be in the libraries directory for the Arduino IDE to find it.
- ☐ Next, you want to verify that the Arduino IDE can find the Time library. Open the Arduino IDE and then click on the Sketch/Import Library menu item. You should see the Time library as shown in **Figure 3**. This verifies that you have successfully added the library to the Arduino directory.
- ☐ Click on 'Time' and it will add `#include <Time.h>` to your source code as shown in **Figure 4**. You are now ready to write code that will use the Time library.
- ☐ Open the File/Examples/Time/Examples/TimeSerial as shown in **Figure 5**.
- ☐ In the *Setup()* function, change the baud rate from 9600 to 57600.



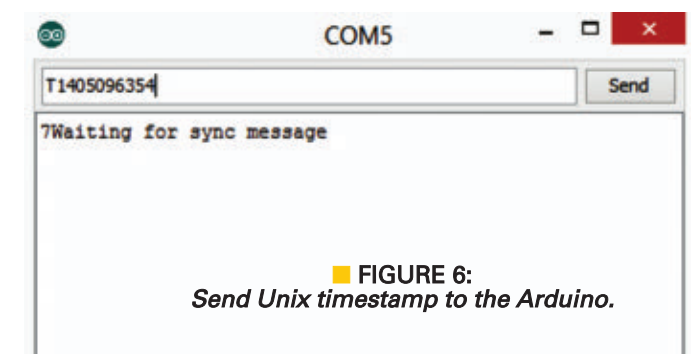
■ **FIGURE 2:**
Put Time in the libraries directory.

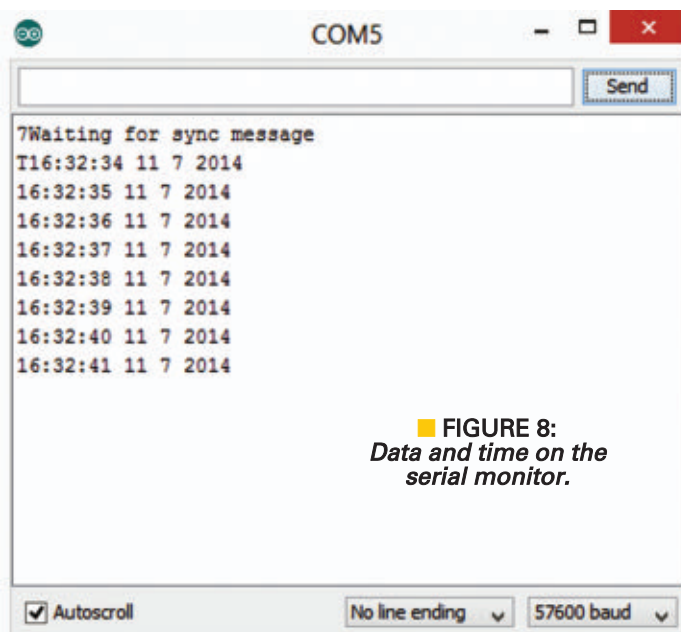


- ❑ In the `requestSync()` function, remove the 'BYTE' parameter from the `Serial.print()` function.
- ❑ Run the program and open the Serial Monitor. You will see the message "Waiting for sync message" displayed as shown in Figure 6.
- ❑ In a computer browser, open www.unixtimestamp.com as shown in Figure 7.
- ❑ QUICKLY copy the Unix time value, which was 1405096354 when I did this exercise as shown in Figure 7.
- ❑ ALSO QUICKLY, paste this value into the serial monitor output box preceded by a 'T' as in Figure 8. I say quickly because the seconds that it takes to copy, paste, and send the Unix time will create an offset of several seconds between the real time (in the opinion of the



- PC) and the time learned by the Arduino.
- ❑ The serial monitor will begin to display the time and date as shown in Figure 8.
- ❑ Note that the time is expressed as a 24 hour clock — as in military time.
- ❑ Also note that the time is UTC — Coordinated Universal Time that is more or less synonymous with Greenwich Mean Time (GMT).
- ❑ Note that converting UTC to your time zone (if you live in the USA) requires considering daylight savings time. I





■ **FIGURE 8:**
*Data and time on the
serial monitor.*

live in the Eastern time zone which is UTC-5:00, but since daylight savings time is in effect it is actually UTC-4:00. The time shown in **Figure 8** as 16:32 was UTC-4:00 or 16:32 - 4:00 = 12:32.

Lab 2: Using Processing to Set the Arduino Time

Hand-typing the Unix timestamp is not so hard, but chances are you will not get the exact seconds this way. You could add a couple of seconds to the total, but you could also use Processing to set it more accurately than you can by hand.

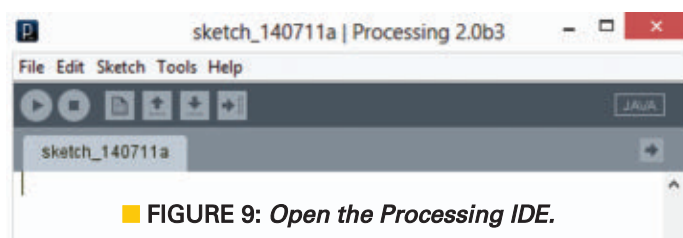
Parts required:

- 1 Arduino
- 1 Computer with Internet connection

Estimated time for this lab: 20 minutes

Check off when complete:

- ☐ Download Processing 2 from www.processing.org. This application is large, so the download may take a while.
- ☐ Open the Processing IDE as shown in **Figure 9**.
- ☐ Download the following program into the Processing IDE. [You can find all the code files at the article link.]



■ **FIGURE 9:** *Open the Processing IDE.*

```
// a101_ch9_receive_serial.pde Joe Pardue
// 7/11/14
// Processing program to receive strings from
// the Arduino

import processing.serial.*;

Serial mySerial;
// Create object from Serial class
String input;
// Data received from the serial port

void setup()
{
  // Find the COM port you are using by looking
  // in the Arduino Tools/SerialPort menu item.
  mySerial = new Serial(this, "COM5", 57600);
}

void draw()
{
  if ( mySerial.available() > 0)
  { // If data is available,
    // put it in the input string
    input = mySerial.readStringUntil('\n');
  }
  println(input); //print it out in the console
}
```

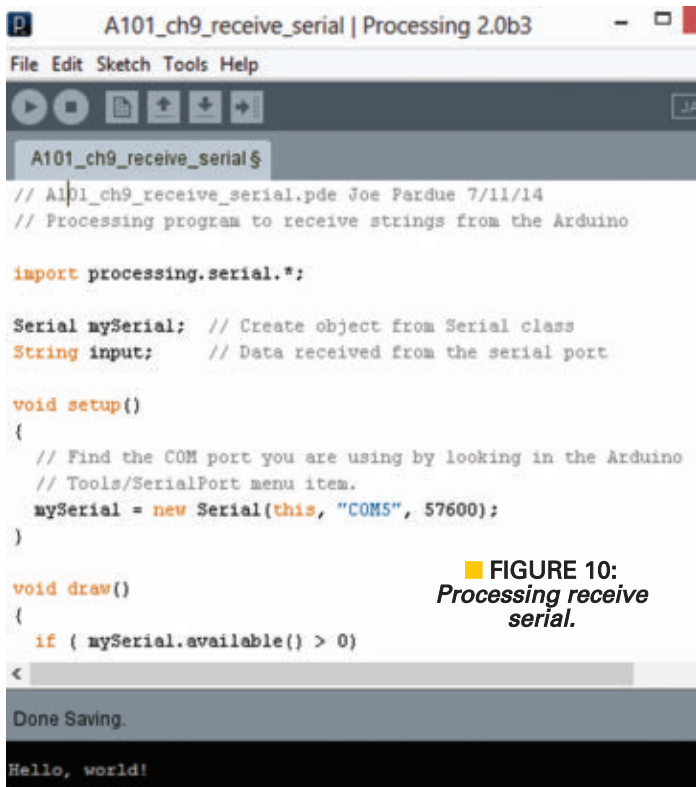
- ☐ Leave the Processing IDE open, but do not run the program yet.
- ☐ Download this program into the Processing IDE:

```
// a101_ch9_hello_world.ino Joe Pardue 7/11/14

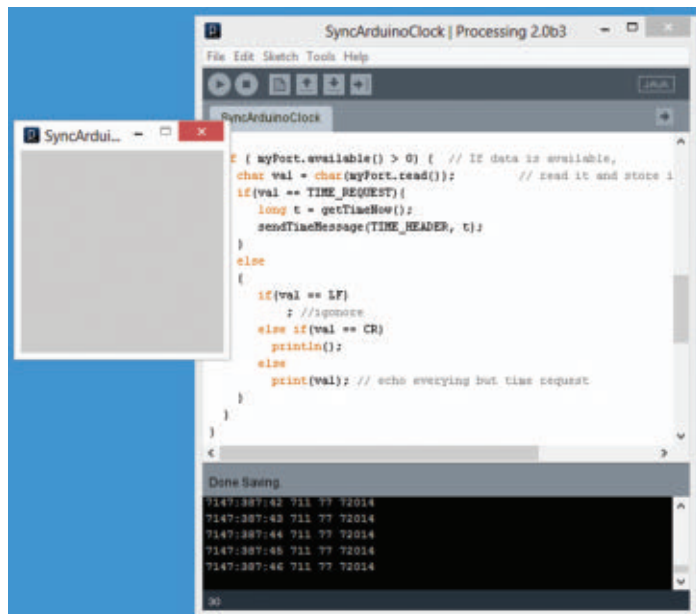
void setup()
{
  Serial.begin(57600);
}

void loop()
{
  Serial.println("Hello, world!");
  // send Hello, world!
  delay(250); // pause for 1/4 second
}
```

- ☐ Compile and run the Arduino program first.
- ☐ Compile and run the Processing program second.
- ☐ The order is important because the Arduino has to open the COM port first.
- ☐ You will see the Processing console (the black area at the bottom of the Processing IDE) begins to print "Hello, world!" as shown in **Figure 10**.
- ☐ Now that you have tested the Processing and Arduino serial connections, reload the *Arduino TimeSerial* example shown in Lab 1. Compile and run that program.
- ☐ In the Processing IDE, load the *SyncArduinoClock* program. We will not discuss this file since it uses some features that are beyond the scope of this article.
- ☐ Run *SyncArduinoClock* in Processing, and you will see a blank window appear as shown in **Figure 11**.
- ☐ Click on this window and the correct time will be sent to the Arduino, which will then print the date and time to the Processing console as we see in **Figure 11**.



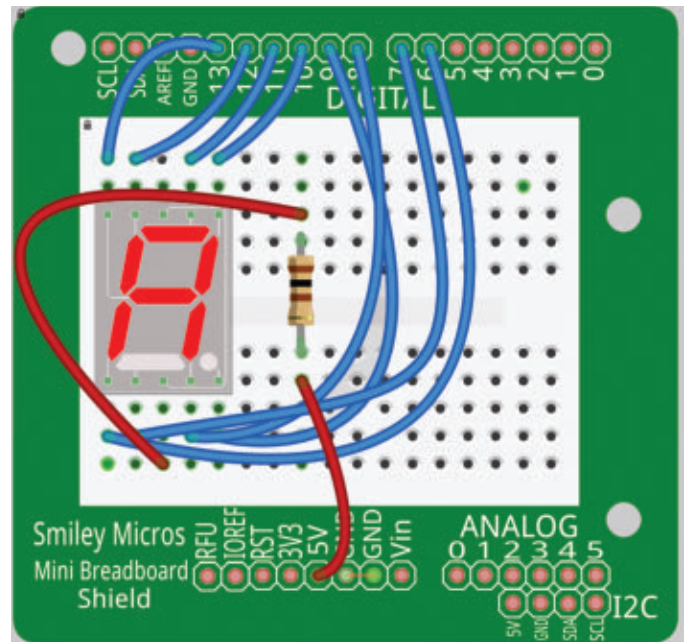
■ FIGURE 10:
Processing receive
serial.



■ FIGURE 11: Run Processing SyncArduinoClock.

Lab 3: One Numeral Clock

Now that we can tell the time, what if we don't have a PC with a USB serial connection to send that time out to a serial terminal? Well, we could display the time on the Arduino using the seven-segment LED. You may well ask, how can we display all that information on a single digit



■ FIGURE 12: Seven-segment LED breadboard.

display? We could do something similar to what we learned in Lab 5 of Chapter 8 where we built "The World's Smallest Moving Message Sign."

We could then display the hour, minute, and second; say, 1:35:12 as H01 M35 S12. By controlling the timing of the character output, this makes a nominally readable display if you know what you are looking for and pay attention.

Parts required:

- 1 Arduino
- 1 Computer with Internet connection
- 1 Arduino proto shield and jumper wires
- 1 Seven-segment LED
- 1 100 Ω resistor

Estimated time for this lab: 1 hour

Check off when complete:

- ☐ Build the circuit shown in Chapter 8 Lab 4. The figures from that lab are repeated here in **Figures 12, 13, and 14** for your convenience. Notice that this circuit uses a single 100 Ω resistor between the seven-segment LED anode pin 3 and the five volt power supply.
- ☐ Load the following program into the Arduino IDE:

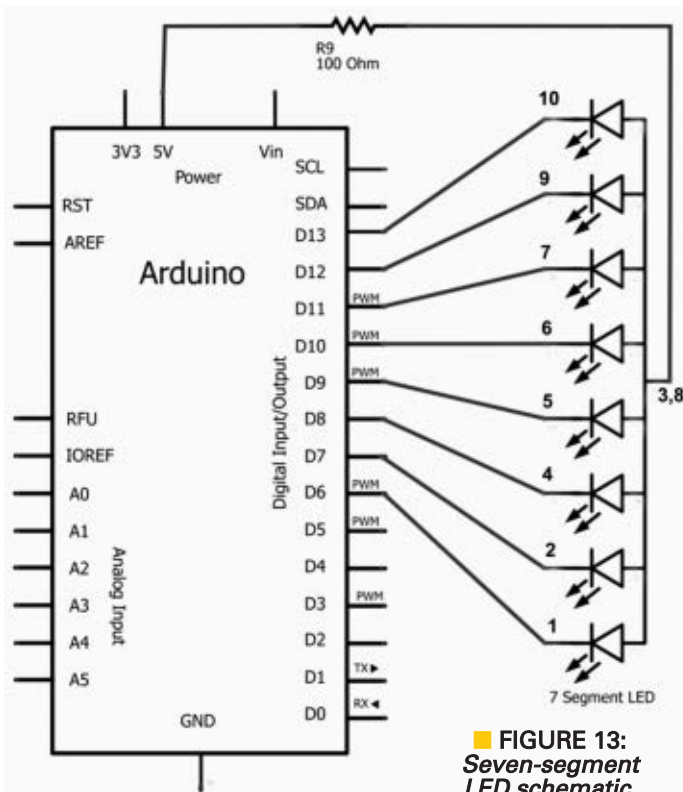
```

// a101_ch9_time_display.ino Joe Pardue 7/13/14
// Modification of TimeSerial.ped

#include <Time.h>

// time sync to PC is HEADER

```



■ **FIGURE 13:**
Seven-segment
LED schematic.

```
// message
#define TIME_REQUEST 7

byte integer[] = {0x3F, 0x06, 0x5B, 0x4F, 0x66,
                  0x6D, 0x7D, 0x07, 0x7F, 0x6F,
                  0x08};
byte character[] = {0x77, 0x7C, 0x39, 0x5E,
                   0x79, 0x71,
                   0x6F, 0x76, 0x30, 0x1E, 0x70, 0x38,
                   0x15, 0x54, 0x3F, 0x73, 0x67, 0x50,
                   0x6D, 0x78, 0x3E, 0x1C, 0x2A, 0x46,
                   0x6E, 0x52};

#define DPMASK 0x80
#define GMASK 0x40
#define FMASK 0x20
#define EMASK 0x10
#define DMASK 0x08
#define CMASK 0x04
#define BMASK 0x02
#define AMASK 0x01

#define DPPIN 9
#define GPIN 13
#define FPIN 12
#define EPIN 6
#define DPIN 7
#define CPIN 8
#define BPIN 10
#define APIN 11

#define PAUSE 500
```

```
// lowest segment starts with LED 6
// highest segment ends with LED 12
int low = 6;
int high = 13;

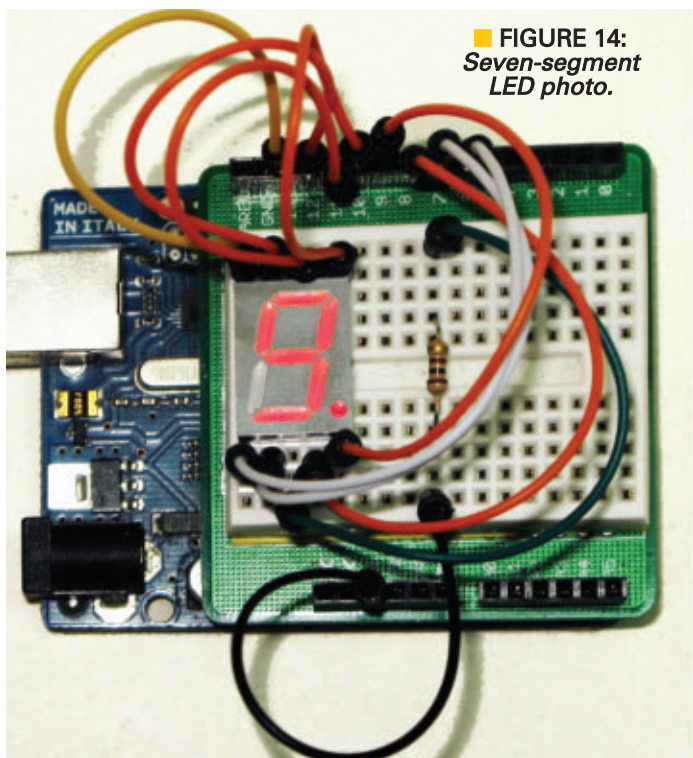
void setup() {

    // Set LED pin modes to output
    for(int i = low; i <=high; i++){
        pinMode(i, OUTPUT);
    }

    Serial.begin(57600);
    Serial.println("a101_ch8_time_display
    rev 1.0");
    //set function to call when sync required
    setSyncProvider( requestSync);
    Serial.println("Waiting for sync message");
}

void loop(){
    if(Serial.available() )
    {
        processSyncMessage();
    }
    if(timeStatus() != timeNotSet)
    {
        // on if synced, off if needs refresh
        digitalWrite(13,timeStatus() == timeSet);
        sevenSegDisplay();
    }
    delay(1000);
}
//*****//
// Functions to display the time on the
// 7-seg LED
//*****//
void sevenSegDisplay(){
    // show the hour
    setLEDs('H');
    delay(PAUSE);
    showDigits(hour());
}
```

```
// followed by unix time_t as ten ascii digits
#define TIME_MSG_LEN 11
// Header tag for serial time sync message
#define TIME_HEADER 'T'
// ASCII bell character requests a time sync
```



■ **FIGURE 14:**
Seven-segment
LED photo.


```

delay(PAUSE*2);

// show the minute
setLEDs('M');
delay(PAUSE);
showDigits(minute());
delay(PAUSE);

// show the second
setLEDs('S');
delay(PAUSE);
showDigits(second());
delay(PAUSE);
}

// Display all time values as two digits
// use leading 0 if value less than 10
void showDigits(int digits){
    int high, low;

    if(digits > 59) high = 6;
    else if(digits > 49) high = 5;
    else if(digits > 39) high = 4;
    else if(digits > 29) high = 3;
    else if(digits > 19) high = 2;
    else if(digits > 9) high = 1;
    else high = 0;

    low = digits - (high*10);

    setLEDs(high+48);
    delay(PAUSE);
    setLEDs(low+48);
    delay(PAUSE);
}

void setLEDs(int input){
    // verify input is integer or character
    if( (input > 47) & (input < 58) )
    {
        input = integer[input - 48];
    }
    else if ( (input > 64) & (input < 91) )
    {
        input = character[input - 65];
    }
    else // it isn't an integer or character
    {
        return; // do nothing if invalid input
    }

    // Turn the segments on or off
    digitalWrite(DPPIN,! (DPMASK&input));
    digitalWrite(GPIN,! (GMASK&input));
    digitalWrite(FPIN,! (FMASK&input));
    digitalWrite(EPIN,! (EMASK&input));
    digitalWrite(DPIN,! (DMASK&input));
    digitalWrite(CPIN,! (CMASK&input));
    digitalWrite(BPIN,! (BMASK&input));
    digitalWrite(APIN,! (AMASK&input));
}

//*****//
// Functions to synchronize the time
//*****//
void processSyncMessage() {
    // if time sync available from serial port,
    // update time
    // time message consists of a header and ten
    // ascii digits
    while(Serial.available() >= TIME_MSG_LEN ) {
        char c = Serial.read() ;
        Serial.print(c);
        if( c == TIME_HEADER ) {
            time_t pctime = 0;

```

```

        for(int i=0; i < TIME_MSG_LEN -1; i++){
            c = Serial.read();
            if( c >= '0' && c <= '9'){
                // convert digits to a number
                pctime = (10 * pctime) + (c - '0') ;
            }
        }
        // Sync Arduino clock to time from the
        // serial port
        setTime(pctime);
    }
}

time_t requestSync()
{
    Serial.print(TIME_REQUEST);
    // the time will be sent later in response
    // to serial mesg
    return 0;
}

```

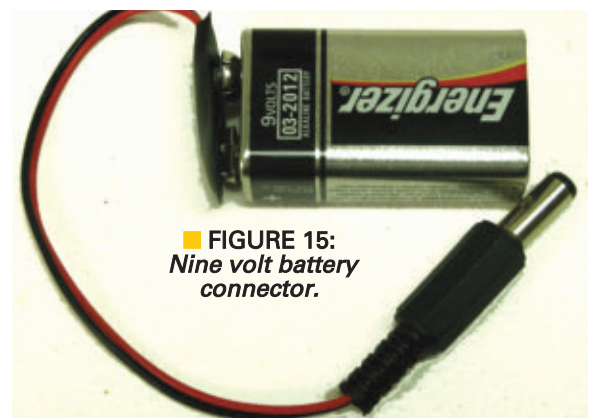
- ☐ Compile and run the program.
- ☐ Do you find it easy to read the hours, minutes, and seconds?

Lab 4: Cut the Apron Strings

So far, we have used the Arduino tethered to the PC. This provides both power and a convenient way to program and talk to the Arduino. We do have to ask, though, what is the use of learning about how to put time on the Arduino if it can always just get the time from the PC? Of course, there isn't any reason to. We would only want to occupy the Arduino with the chore of keeping time if it is detached from a PC, say sitting out in the garden soaking up the sunshine while leisurely gathering data about the weather.

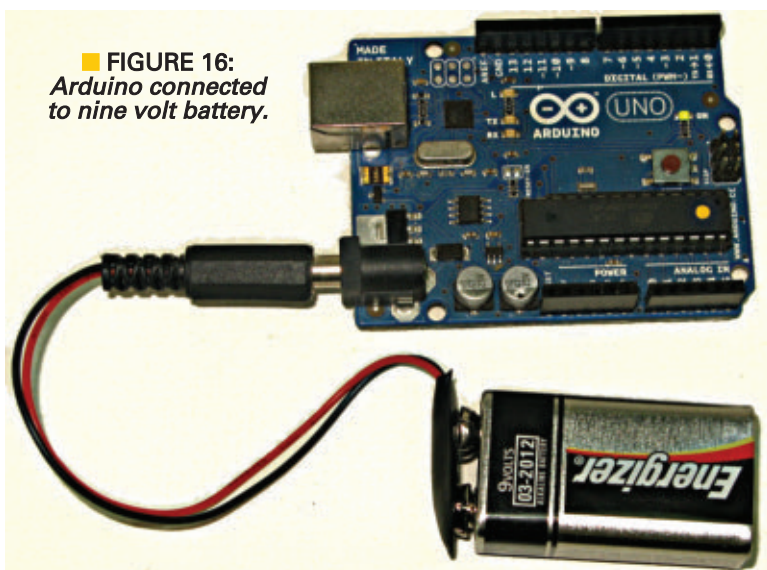
If, for instance, it takes the temperature every five minutes, it will need to know when five minutes have passed. It will also need to know which particular five minutes in a day of lots of five-minute intervals that this particular five minutes occurred. If it isn't attached to a PC out in the garden, where will it get its power?

From a battery, of course. The Arduino has a barrel connector so you can power it with a nine volt battery using a snap connector as shown in **Figure 15**. You can



■ **FIGURE 15:**
Nine volt battery
connector.

■ **FIGURE 16:**
*Arduino connected
to nine volt battery.*



get one at www.adafruit.com/products/80. Connect the nine volt battery as shown in **Figure 16** and you are ready to run your Arduino away from a computer.

This process of gathering information external to a

computer is called data logging, and it is used to record sensor readings over known intervals at known dates and times. In later chapters, we will learn how to use sensors, but first we will learn how to keep time so that we can log the sensor data and know when we took our readings.

Parts required:

- 1 Arduino
- 1 Computer with Internet connection
- 1 Barrel connector with snap connections
- 1 Nine volt battery

Estimated time for this lab: 15 minutes (+24 hours)

Check off when complete:

- ☐ Attach a nine volt battery to the snap connections as shown in **Figure 15**.
- ☐ Plug the nine volt battery into the Arduino barrel connector as shown in **Figure 16**.
- ☐ Calibrate the clock as you did in Lab 2.
- ☐ Remove the USB connector and wait 24 hours.
- ☐ **DO NOT** plug in the USB cable. If you attempt to contact the Arduino via USB, it will reset and you will lose the time and have to start over.
- ☐ Refer to your PC time clock for the correct time and then compare this to the time being displayed on the Arduino.
- ☐ What is your error in seconds per day?

As we said earlier, this isn't a particularly accurate clock. In order to get really good accuracy, you'll need to use an external RTC like what was discussed in the Smiley's Workshops mentioned earlier. However, as we will see when we look at data logging, our clock is good enough to time a days' worth of measurements, and you can resync it each day when you upload the data you have logged.

Next month, we will learn to use light and temperature sensors with the Arduino in preparation for the following month when we will use those sensors and what we have learned about time to build a data logger.

Remember that all the components used in the Arduino 101 series are available from the *Nuts&Volts* webstore for convenience. If you have any questions about this series, be sure to visit the forum at www.arduino4classroom.com and ask. **NV**

WORLD'S MOST VERSATILE CIRCUIT BOARD HOLDERS



Model 324

Our Circuit Board Holders add versatility & precision to your DIY electronics project. Solder, assemble & organize with ease.



Model 201

VISIT US ON

MONTHLY CONTEST
Visit us on Facebook® to post a photo of your creative PanaVise project for a chance to win a PanaVise prize package.

PANAVISE®

Innovative Holding Solutions

7540 Colbert Drive • Reno • Nevada 89511 | (800) 759-7535 | www.PanaVise.com

CLASSIFIEDS

SURPLUS

SURPLUS ELECTRONIC PARTS & ACCESSORIES

Over 20,000 Items in Stock. Cables Connectors Displays Fans Hardware LEDs Motors Potentiometers Relays Semiconductors Service Manuals Speakers Switches Test Equipment Tools VCR Parts

Surplus Material Components SMC ELECTRONICS www.smcelectronics.com No Minimum Order. Credit Cards and PAYPAL Accepted. Flat \$4.95 per order USA Shipping.

LIGHTING



LED modules
Solar controls
Dusk to dawn
Dimmers 12/24V

J2 LED LIGHTING LLC
www.j2ledlighting.com

MISC FOR SALE

WANT TO BUY: WHOLESALE OR MANUFACTURING COMPANY. Inventory, machinery, equipment, bank foreclosures, estates. ANYTHING CONSIDERED. NO COST OR OBLIGATION. Now in our 35th year. Visit www.iseliquidator.com 956-444-0004, 888-351-5550

Like to build robots? Then, you need a subscription to **SERVO!**



www.servomagazine.com

KITS/PLANS

QKITS LTD
sales@qkits.com

1 888 GO 4 KITS

Arduino • Raspberry Pi
Power Supplies
MG Chemicals
RFID



Visit us at:
www.qkits.com

ROBOTICS

MaxBotix
High Performance Ultrasonic Rangefinders

Check us out Today!

HRXL-MaxSonar[®]-WR™
- High noise tolerance
- IP67 rated
- 1 mm resolution
- Multi-Sensor operation
- Calibrated beam pattern
- Starting at \$109.95

Save 10% NOW
On Web Orders
Enter Code: NV311014
Code valid thru November 30, 2014



XL-MaxSonar[®]-EZ™
- Great for UAV's and robotics
- Incredible noise immunity
- Small in size
- 1cm resolution
- Automatic calibration
- Starting at \$39.95



Phone: 218-454-0756 Email: sales@maxbotix.com
www.maxbotix.com

CONTROLLERS

Join The
**INTERNET of THINGS
REVOLUTION**



TRI SUPER PLCs

Powerful & Easy Ladder
+BASIC Programming
Ethernet Integrated
MODBUS TCP/IP
DI/Os & AI/Os Integrated

tel : 1 877 TRI-PLCS
web : www.triplc.com/nv.htm

TRI TRIANGLE
RESEARCH
INTERNATIONAL

AUDIO/VIDEO PARTS

ICEpower MODULES

50W x 2 (50ASX2) or
170W x 1 (50ASX2BTL)
Just add AC & speaker(s)
\$99 USA \$119 Worldwide
www.classicaudioparts.com

**PARTS
EXPRESS**
YOUR ELECTRONICS CONNECTION™

**OVER 18,000
ELECTRONIC PARTS
IN STOCK**



Speakers



Components



**Project
Accessories**



**Tools and
Tech Aids**

Call or visit us online today to receive
your **FREE** copy of our 2014 catalog!

parts-express.com/nuts
1-800-338-0531

SERVICES

Sandtronics

Sandpiper Electronics Services LLC

"design of custom electronics instrumentation"

Circuit design & drawings, PCB layout, fabrication & population
Prototype development for research, industry and inventors.
39 years experience in electronics development for research &
flight applications, laser systems & laboratory research

FREE no obligation consultations
www.sandtronics.com

HARDWARE WANTED

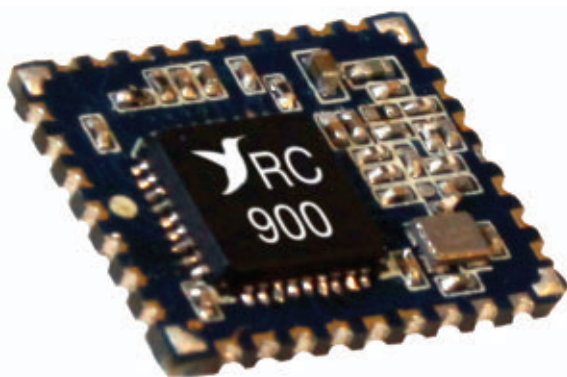
**DEC EQUIPMENT
WANTED!!!**

Digital Equipment Corp.
and compatibles.
Buy - Sell - Trade

CALL KEYWAYS 937-847-2300
or email buyer@keyways.com

NEW PRODUCTS

Continued from page 28



HumRC™: At below \$9 in volume, the HumRC is a very low cost/complete wideband transceiver with a microcontroller module.

The HumRC is designed for reliable bi-directional remote control and sensor applications. The module includes a Frequency Hopping Spread Spectrum (FHSS) protocol and supports versions at 2.4 GHz and 900 MHz with a common footprint and pin-out in this initial release, with 868 MHz and others to follow in the near future. This common footprint across the available frequencies makes it suitable for global sale, so one product can be manufactured and sold around the world.

Designed with low cost in mind, the RF module

Continued on page 81

>>> QUESTIONS

555 for PWM

Does anyone have a simple circuit/schematic to use a 555 timer to dim a 120 VAC incandescent bulb? In the little bit of research I've done, it seems like using the 555 for PWM should do the trick, but I don't understand "zero crossing" and why it's important. Pointers welcome!

#10141 **Chuck Pearson**
Kansas City, MO

Commodore Troubleshooting

I recently inherited a 1980's era Commodore SX-64 computer. Though it looks cosmetically perfect, it doesn't power up (i.e., the little monitor lights up with a plain gray color, but there is no sound or picture). Anyone have any pointers on where to begin troubleshooting this unit?

#10142 **Dani Sanders**
Salt Lake City, UT

Carbon or Metal?

Is there a rule of thumb for when it is better to use carbon film resistors over metal film resistors?

#10143 **Brayden Lawlor**
Norfolk, VA

Chinese Capacitor Problem

I have a Viewsonic model VG2230WM LCD monitor that has quit. I read that these monitors have the "Chinese capacitor problem" but I can't figure out what exactly that means and what to do to fix it. Do I just replace all the caps on the PCB?

#10144 **Jouko Koskela**
Memphis, TN

>>> ANSWERS

[#7141 - July 2014] Photoresistor Switcher

I would like to know if I have correctly connected my photoresistors (CdS photocells) in order to turn the two LED circuits attached to them OFF during the day and ON during the night. (If not, please indicate by a new diagram.)

Also, I would like to know:

a) *If any photoresistor would work?*

b) *What would the optimum dark/light resistance values be for such a photoresistor?*

c) *How would I calculate the values (any formula?) from the transistor side (2N2222) that would best fit this ON/OFF photoresistor switcher?*

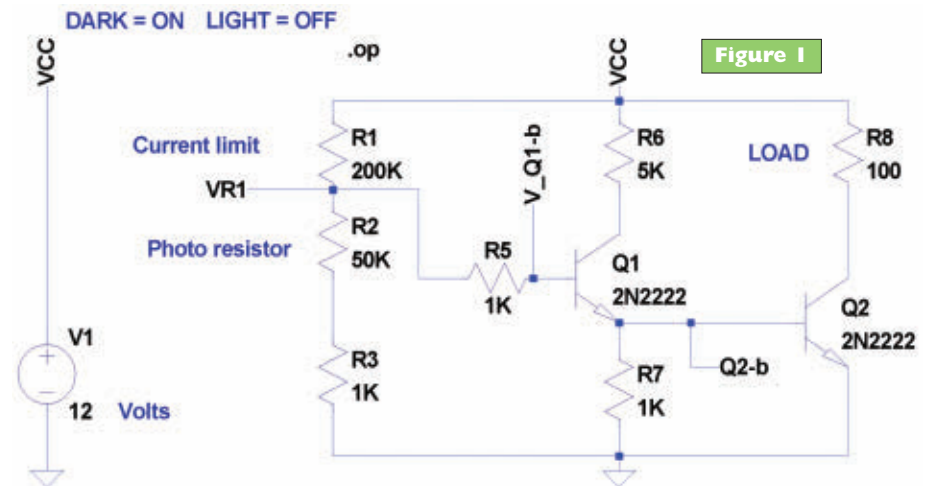
First of all, a power supply was not specified. The top circuit operating range using common 555s is from five to 15 volts according to the datasheet.

The IC 4017 datasheet specifies current drive limit to be about one milliamp. Some amplification is required to drive an LED at 10 to 20 milliamps. The bottom circuit requires at least 12 volts to operate a series string of LEDs. Three LEDs in series add up to: $G(3.2) + R(1.8) + G(3.2) = 8.2$ volts. This requires at least 12 volts of power to allow for a current-limiting resistor voltage drop. LEDs will load down a ring oscillator. You need a high impedance buffer to isolate the LEDs from the resistor capacitor time constant.

a) The logic of operation of CDS photocells is:

No Light = High resistance
Max Light = Low resistance

As shown, that logic will tend to turn on the transistor during the daytime and turn it off during the night. A simple solution is to swap the 100K resistor with a photoresistor in-circuit. You will probably need to



All questions AND answers are submitted by *Nuts & Volts* readers and are intended to promote the exchange of ideas and provide assistance for solving technical problems. All submissions are subject to editing and will be published on a space available basis if deemed suitable by the publisher. Answers are submitted

by readers and **NO GUARANTEES WHATSOEVER** are made by the publisher. The implementation of any answer printed in this column may require varying degrees of technical experience and should only be attempted by qualified individuals.

Always use common sense and good judgment!

adjust the resistor values to operate the way you require. You also need to limit the current into the base of the transistor. Not every photoresistor will work as the range of resistance variation must match the required transistor bias. You could measure the resistance of the photoresistor with an ohmmeter for both dark and light

Send all questions and answers by email to forum@nutsvolts.com
or via the online form at www.nutsvolts.com/tech-forum

environments, or look up the datasheet from Digi-Key, Mouser, or the manufacturer. Refer to **Figure 1** from the Linear Technology SPICE program.

Some CDS photoresistors are about 200K ohms in the dark and about 4K ohms in light. If the range is less, the transistors will always stay on. Measure the photoresistor in light with an ohmmeter. Cover the photo resistor to measure dark resistance.

b) Optimum bias would provide about 0.6 to 1.0 volts or more at the transistor base (relative to the emitter) to turn on, and less than that threshold to turn off. Depends on required current from collector to emitter.

As mentioned, you did not specify your power supply voltage. The 555 IC works best from about five to 15 volts. Three LEDs in series need at least 12 volts as shown.

Two red LEDs and 470 ohms minus (diode drops and IC drop):

$$(12 - (1.8 + 1.8) \text{ volt} - 1) = 6.4 \text{ volts}$$

$$\text{Max current} = 6.4 \text{ volts} / 470 \text{ ohms} = 14 \text{ milliamps}$$

The three LEDs with a 1K resistor operating at 10 milliamps would require:

$$\text{VDC} = (0.01 \text{ amp} * 1000 \text{ ohm}) + (1.8)R + (3.2)G + (3.2)G = 8.2$$

$$12 - 8.2 = 3.6 \text{ volts}$$

$$3.6 \text{ volts} / 470 \text{ ohms} = 7.6 \text{ milliamps}$$

$$R8 \text{ is } 330 \text{ ohms for } 10 \text{ milliamps.}$$

Current limit for the 4017 source is about one milliamp out. You'll need transistor drivers. 470 ohms drives about 14 milliamps. A ring oscillator may not work as LEDs are loading RC timing; transistor emitter followers may help. The Linear Technology SPICE program can be used to experiment with different values.

Calculation for transistor bias:

R1 = base to power bus VCC

R2 = base to ground or common

$$\text{Vbase} = \text{VCC} * (R2 / (R1 + R2))$$

This is the first approximation as some current will go into the base of the transistor. The switch point is in the range from 0.6 to 1.0 volts. High on; low off. Take a look at Ohm's Law.

The circuits shown here are available in the Tech Forum at www.nutsvolts.com. The .PDF file is directly viewable. The .asc format is editable within Linear Technology SPICE. LTSpice is free from the Linear Technology website.

Adjust the photoresistor value for the version you have in a light and dark environment. Verify that the LOAD has a reasonable current (ON value) of about 10 to 100 milliamps or negligible current (OFF value).

[#8144 - August 2014] Flashlight to Flashing Light

I have a small LED flashlight that I mount on my handlebars while riding my bike at night. I've seen some people put a flashing white light on the front of their bikes. Is there a circuit to convert my "regular" flashlight to a "flashing" flashlight?

#1 There are a number of different multi-mode LED flashlight driver modules available — many of which include flashing modes. Check out the selection at dx.com. Make sure to get one that supplies a current appropriate for the LED in your light. They also carry complete lights based around similar modules, which might be easier than trying to modify your existing flashlight.

James Sweet
via email

#2 When I read the question, I remembered that RadioShack sold a blinking LED but in red (part 276-0036). I bought the LED, and tested the current flow while it was blinking. I discovered that the IC inside reduces the current to less than 0.03 mA (30 μ A) when off, and conducts over 40 mA when on. So, you can buy the

blinking LED and add it in series to your LED flashlight. When you turn the flashlight on, the red LED will blink, and make the main LED blink, too.

You will have to open the bicycle flashlight to wire the blinking LED in series to the white LED. This LED can handle up to five volts and up to 80 mA (as printed on the package) with no additional components. If you do a Web search on the part number, you can find other bicycle projects using the same blinking red LED to flash an array of nine red LEDs for the rear light.

Raymond J. Ramirez
via email

[#9142 - September 2014] UV LED vs. UV Bulb

I'm been working a lot with high power LEDs now that they're so affordable. I'm especially fond of the UV LEDs for visual effects at night, but I've heard that some UV LEDs can cause blindness, and that I should use a UV bulb to create the effects. Is this true? Can someone explain the difference?

The safety difference between a UV lightbulb and a UV LED stems from the difference in radiance between the two sources. Radiance is basically the density of light in the source.

The surface area of an incandescent-size lamp is approximately 100,000 sq-mm. The source area of a high power LED is perhaps 2 sq-mm. While its likely a single high power LED will produce less optical energy than the bulb, the radiance is still likely thousands of times greater for the LED and hence its greater potential for eye damage.

In practice, as long as you don't look directly at the light source but rather the light reflected from the objects of interest, there is little difference between the two sources.

Steve Paolini
via email

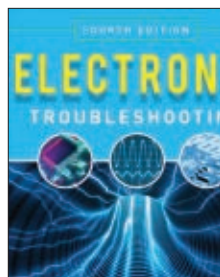
GREAT FOR DIYers!

Electronic Troubleshooting, Fourth Edition by Daniel Tomal, Aram Agajanian

Electronic Troubleshooting, Fourth Edition provides technicians with a wealth of problem-solving methods and information on troubleshooting theory, techniques, and practices for a wide variety of electrical and electronic devices. Special emphasis is placed on the digital electronics and microprocessor-based systems that are used in today's industrial and personal applications.

Regular Price \$70.00

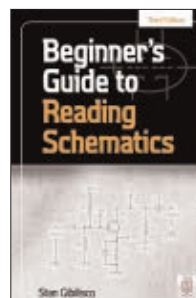
Sale Price \$59.95



Beginner's Guide to Reading Schematics, 3E by Stan Gibilisco

Navigate the roadmaps of simple electronic circuits and complex systems with help from an experienced engineer. With all-new art and demo circuits you can build, this hands-on, illustrated guide explains how to understand and create high-precision electronics diagrams. Find out how to identify parts and connections, decipher element ratings, and apply diagram-based information in your own projects.

\$25.00



Make Your Own PCBs with EAGLE by Eric Kleinert

Featuring detailed illustrations and step-by-step instructions, *Make Your Own PCBs with EAGLE* leads you through the process of designing a schematic and transforming it into a PCB layout. You'll then move on to fabrication via the generation of standard Gerber files for submission to a PCB manufacturing service. This practical guide offers an accessible, logical way to learn EAGLE and start producing PCBs as quickly as possible.

\$30.00



Programming the BeagleBone Black: Getting Started with JavaScript and BoneScript by Simon Monk

Learn how to program the BeagleBone Black — the wildly popular single-board computer — using JavaScript and the native BoneScript language. You'll find out how to interface with expansion capes to add capabilities to the basic board, and how to create a Web interface for BBB. Two hardware projects demonstrate how to use the board as an embedded platform.

\$15.00



Build Your Own Transistor Radios by Ronald Quan A Hobbyist's Guide to High Performance and Low-Powered Radio Circuits

Create sophisticated transistor radios that are inexpensive yet highly efficient. Inside this book, it offers complete projects with detailed schematics and insights on how the radios were designed. Learn how to choose components, construct the different types of radios, and troubleshoot your work.

***Paperback, 496 pages**

\$49.95



The Steampunk Adventurer's Guide by Thomas Willeford

Steampunk stalwart Thomas Willeford cordially invites you on an adventure — one in which you get to build ingenious devices of your own! Lavishly illustrated by award-winning cartoonist Phil Foglio, *The Steampunk Adventurer's Guide: Contraptions, Creations, and Curiosities Anyone Can Make* presents 10 intriguing projects ideal for makers of all ages and skill levels, woven into an epic tale of mystery and pursuit.

Regular Price \$25.00

Sale Price \$19.95



How to Diagnose and Fix Everything Electronic by Michael Jay Geier

Master the Art of Electronics Repair

In this hands-on guide, a lifelong electronics repair guru shares his tested techniques and invaluable insights. *How to Diagnose and Fix Everything*

Electronic shows you how to repair and extend the life of all kinds of solid-state devices, from modern digital gadgetry to cherished analog products of yesteryear.

\$24.95



Programming PICs in Basic by Chuck Hellebuyck

If you wanted to learn how to program microcontrollers, then you've found the right book! Microchip PIC microcontrollers are being designed into electronics throughout the world and none is more popular than the eight-pin version. Now the home hobbyist can create projects with these little microcontrollers using a low cost development tool called the CHIPAXE system and the Basic software language. Chuck Hellebuyck introduces how to use this development setup to build useful projects with an eight-pin PIC12F683 microcontroller. **\$14.95**



Programming Arduino Next Steps: Going Further with Sketches by Simon Monk

In this practical guide, electronics guru Simon Monk takes you under the hood of Arduino and reveals professional programming secrets. Also shows you how to use interrupts, manage memory, program for the Internet, maximize serial communications, perform digital signal processing, and much more. All of the 75+ example sketches featured in the book are available for download. **\$20.00**



Order online @ www.store.nutsvolts.com
Or CALL 1-800-783-4624 today!

EDUCATIONAL

Beginner's Guide Complete Combo!



Combo Price \$229.95

For complete details, visit our webstore @ www.nutsvolts.com.

An Arduino Workshop

Are you puzzled about the Arduino but finding it difficult to get all the pieces in one place?



Joe Pardue
SmileyMicros.com

Book and Kit Combo \$124.95

Arduino Classroom Arduino 101 Projects Kit



\$44.99

From Smiley's Workshop

CD-ROM SPECIAL

Nuts & Volts 10 CD-ROMs & Hat Special!

That's 120 issues.
Complete with supporting
code and media files.



Free Shipping!

Only \$208.95
or \$24.95 each.



**The Nuts & Volts
Pocket Ref**

All the info you need at your fingertips!

This great little book is a concise
all-purpose reference featuring
hundreds of tables, maps,
formulas, constants &
conversions.

Only \$12.95

AND it still fits in
your shirt pocket!

Visit <http://store.nutsvolts.com> or call (800) 783-4624

PROJECTS

Fading Eyes Deluxe Board



The fading eyes circuit gives you two LED eyes that can be adjusted between a slow fade-in/fade-out to quick pulses. The speed is changed by simply adjusting the variable resistor with a small screw driver. Another adjustment allows you to set how long the LED stays on within the on/off fade cycle. Includes a battery snap and two red LEDs and two 24 inch eye cables.

\$15.95

Peek-a-Boo Ghost Kit



The Peek-a-Boo Ghost kit is a fun, low cost multi-use microcontroller kit. When triggered by the included motion sensor, this mini animatronic waves its arms, lights its LED eyes, and plays back the sounds you record. Perfect for kids, this kit can be used to create a fun Halloween prop for your desk, front door, or walkway. Watch the video to see this cool kit in action. Available in both a program-it-yourself version or with a pre-programmed PICAXE chip option.

Unprogrammed Chip Kit \$29.95

Preprogrammed Chip Kit \$37.95

Talking Skull Kit



Now back in the Nuts Volts webstore, the new and improved Talking Skull Kit. The new kit includes the much improved audio, servo driver board, see all the improvements in our webstore. This kit provides all the supplies necessary to build one talking skull. You provide the labor and tools and you'll have a great Halloween prop in no time!

\$97.95

Geiger Counter Kit

As seen in the March 2013 issue.

This kit is a great project for high school and university students. The unit detects and displays levels of radiation, and can detect and display dosage levels as low as one micro-roentgen/hr. The LND712 tube in our kit is capable of measuring alpha, beta, and gamma particles.

Partial kits also available.

\$159.95



Solar Charge Controller Kit 2.0



If you charge batteries using solar panels, then you can't afford not to have them protected from over-charging. This 12 volt/12 amp charge controller is great protection for the money. It is simple to build, ideal for the novice, and no special tools are needed other than a soldering iron and a 9/64" drill!

\$27.95

Super Detector Circuit Set



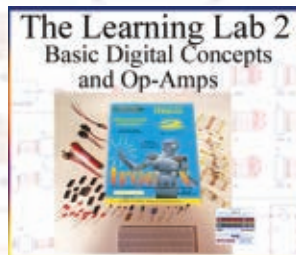
Pick a circuit! With one PCB you have the option of detecting wirelessly: temperature, vibration, light, sound, motion, normally open switch, normally closed switch, any varying resistor input, voltage input, mA input, and tilt, just to name a few.

\$32.95

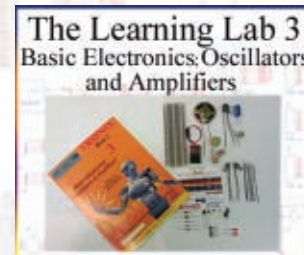
FOR BEGINNER GEEKS!



\$59.95



\$49.95



\$39.95

The labs in this series — from GSS Tech Ed — show simple and interesting experiments and lessons, all done on a solderless circuit board.

As you do each experiment, you learn how basic components work in a circuit, and continue to build your arsenal of knowledge with each successive experiment.

For more info and a promotional video, please visit our webstore.

combines simplicity and advanced system on chip (SoC) technology in a tiny PLCC32 footprint package less than 14 mm x 12 mm. It is nearly half the cost of similar modules, and becomes very competitive with the concept of discrete designs. Having this common footprint across all of its available frequencies complementing its small size, the HumRC appeals to OEMs who have a limited budget to incorporate RF.

The transceiver offers agility by having eight lines that can be configured as either inputs for buttons or outputs to drive circuitry. It has selectable automatic acknowledgements that can include up to two bytes of custom data which can be additional control codes, sensor values, or battery

voltage — whatever the application needs. No programming is required for basic remote control operation, but a serial UART interface is included for more advanced operation.

All functions can be controlled by serial commands, allowing more functionality with fewer hardware connections. It also has two analog lines that can be connected to sensors, and the capability to interrogate the voltage on those lines remotely. For basic sensor applications, the module can replace the microcontroller, reducing the overall cost of the end product and the programming burden in design.

To aid rapid development, the HumRC Series transceiver is available as part of a newly conceived type of

master development system. This comprehensive development kit is designed to assist in the rapid evaluation and integration of the HumRC remote control and sensor transceiver modules. The all-inclusive system features several pre-assembled evaluation boards which include everything needed to quickly test the operation of the transceiver modules. Due to the advanced modular approach to the Master development kit, designers can take advantage of only buying certain boards such as additional prototype boards, remote boards, and other components.

For more information, contact:
Linx Technologies
 Web: www.linxtechnologies.com

■ LOOK FOR ■ SEARCH FOR ■ FIND

Find your favorite advertisers here!

AMATEUR RADIO AND TV

National RF28
 Ramsey Electronics82-83

EDUCATION

Boca Bearings45

BUYING ELECTRONIC SURPLUS

Earth Computer Technologies59
 Weirdstuff Warehouse28

CCD CAMERAS/VIDEO

Ramsey Electronics82-83

CIRCUIT BOARDS

Accutrace Inc..13
 AP Circuits26
 Digilent4
 Dimension Engineering.....59
 ExpressPCB50
 Front Panel Express LLC27
 PCB Pool17
 Saelig Co. Inc.Back Cover

COMPONENTS

Boca Bearings45
 NTEPartsDirect17

COMPUTER

Hardware
 Earth Computer Technologies59
 Weirdstuff Warehouse28

Microcontrollers / I/O Boards

Images Co.13
 M.E. Labs.....16
 MikroElektronika3
 Parallax, Inc.45
 Technologic Systems17

DESIGN/ENGINEERING/ REPAIR SERVICES

Accutrace Inc..13
 Bakatronics28
 ExpressPCB50
 Front Panel Express LLC27

Images Co.13
 National RF28
 PCB Pool17

EDUCATION

Boxed Kit Amps28
 Command Productions27
 Digilent4
 NKC Electronics28
 Poscope55

EMBEDDED TOOLS

NetBurner2

ENCLOSURES

Front Panel Express LLC27

HALLOWEEN

Akitika66
 Bakatronics28
 DC Props28
 Find A Haunt9
 HauntCon55
 Skeletons and More66

HI-FI AUDIO

Boxed Kit Amps28

KITS & PLANS

Bakatronics28
 Boxed Kit Amps28
 Earth Computer Technologies59
 NetBurner2
 NKC Electronics28
 Ramsey Electronics82-83

MISC./SURPLUS

All Electronics Corp.54
 Boca Bearings45
 Front Panel Express LLC27
 NTEPartsDirect17
 Weirdstuff Warehouse28

MOTORS

Servo City/Robot Zone5

PCB ASSEMBLY

Accutrace Inc..13

PNEUMATICS

DC Props28

PROGRAMMERS

M.E. Labs16
 MikroElektronika3

RF TRANSMITTERS/ RECEIVERS

National RF28

ROBOTICS

DC Props28
 Digilent4
 Lemos International Co.63
 Servo City/Robot Zone5

SATELLITE

Lemos International Co.63

TEST EQUIPMENT

Dimension Engineering.....59
 Images Co.13
 NKC Electronics28
 Pico Technology7
 Poscope55
 Saelig Co. Inc.Back Cover

TOOLS

MikroElektronika3
 NetBurner2
 PanaVise74
 Poscope55

VIDEO/DISPLAY MODULES

4D Systems39

WIRE, CABLE AND CONNECTORS

Servo City/Robot Zone5

4D Systems	.....39
Accutrace Inc..	.....13
Akitika	.....66
All Electronics Corp.	.....54
AP Circuits	.....26
Bakatronics	.....28
Boca Bearings	.....45
Boxed Kit Amps	.....28
Command Productions	.....27
DC Props	.....28
Digilent	.....4
Dimension Engineering.....	59
Earth Computer Technologies	59
ExpressPCB	.....50
Find A Haunt	.....9
Front Panel Express LLC	...27
HauntCon	.....55
Images Co.	.....13
Lemos International Co.	.....63
M.E. Labs.....	16
MikroElektronika	.....3
National RF.....	28
NetBurner	.....2
NKC Electronics	.....28
NTEPartsDirect	.....17
PanaVise	.....74
Parallax, Inc.	.....45
PCB Pool	.....17
Pico Technology	.....7
Poscope	.....55
Ramsey Electronics	.....82-83
Saelig Co. Inc.	....Back Cover
Servo City/Robot Zone	.....5
Skeletons and More	.....66
Technologic Systems	.....17
Weirdstuff Warehouse	.....28



RAMSEY Spooktacular Halloween Treats!



Blinky-Eyes Animated Display

- ✓ Animated display of 66 super bright LED's!
- ✓ Microcontroller controlled!
- ✓ Changes brightness automatically!
- ✓ Animated with constant motion!

The ultimate animated LED kit that will dazzle you and delight your friends! Uses a microcontroller to randomly select from many different animations such as a long pause before a wink, or a twinkle of the eye to startle passers-by!



Four modes to satisfy any enthusiast's desires: 1. Off for long random periods, then blinks or winks. Designed to scare! 2. On for long periods before performing an animation, perfect for costumes and displays! 3. Animates all the time for constant motion, perfect display attention-getter. 4. Random fire! When placed in a pumpkin will light it up like you wouldn't believe! As if this weren't enough, the BE66 can also control a small hobby motor to shake bushes at random intervals or signal an external player to make a scary sound! Also has a CDS cell to sense light. In one mode, the display will dim as it gets dark for battery operation, and in the other mode it will turn off when it's too bright, so it plays only in the dark!

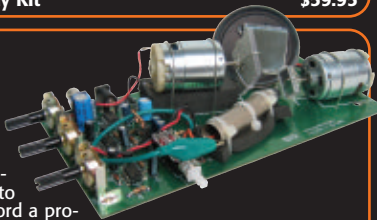
BE66 Blinky-Eyes Animated Display Kit

\$59.95

Laser Light Show

- ✓ Audio input modulates pattern!
- ✓ Adjustable pattern & size!
- ✓ Projects neat motorized patterns!
- ✓ Uses safe plastic mirrors!

You've probably seen a laser show at concerts or on TV. They're pretty impressive to say the least! Knowing that you can't afford a professional laser display we challenged our engineers to design one that's neat and easy to build, yet inexpensive.



Well, the result is the LLS1 Laser Light Show! This thing is sweet and perfect for your haunted house or Halloween parties! It utilizes two small motors and a small standard laser pointer as the basics. Then, we gave it variable pattern and speed controls to customize the pattern!

Not enough, you say? How about a line level audio input to modulate the pattern with your CD's, music, or spooky sound effects? You bet! Everything is included, even the small laser pointer. Runs on 6-12 VDC or our standard AC adapter.

LLS1 Laser Light Show Kit
AC121 12VDC 1A Regulated Power Supply

\$49.95
\$9.95

Tri-Field Meter & "Ghost Detector"

- ✓ See electric, magnetic, and RF fields!
- ✓ Watch the magnetic fields of the earth!
- ✓ Sense different magnetic poles
- ✓ Detect RF transmitter fields
- ✓ Graphical LED display allows you to "see" the invisible fields
- ✓ Great learning tool for EMF, RF, and magnetic field theory

THE GHOST
DETECTOR!



Call it a Tri-Field Meter, an Electrical, Magnetic, and RF Detector, a Ghost Detector, or a Tricorder, but walking around with this on Halloween will seriously impress even the most doubting of Thomases out there!

The TFM3C has three separate field sensors that are user selectable to provide a really cool readout on two highly graphical LED bargraphs! Utilizing the latest technology, including Hall Effect sensors, you can walk around your house and actually "SEE" these fields around you! You will be amazed at what you see. How sensitive is it? Well, you can see the magnetic field of the earth... THAT'S sensitive!

The technical applications are endless. Use it to detect radiation from monitors and TV's, electrical discharges from appliances, RF emissions from unknown or hidden transmitters and RF sources, and a whole lot more! If you're wondering whether your wireless project or even your cell phone is working, you can easily check for RF! A 3-position switch in the center allows you to select electric, magnetic, or RF fields. A front panel "zero adjust" allows you to set the sensors and displays to a known clean "starting point." If the TFM3C looks familiar, it's probably because you saw it in use on the CBS show Ghost Whisperer! It was used throughout one episode (#78, 02-27-2009) to detect the presence of ghosts!

The concept is simple, it is believed (by the believers!) that ghosts give off an electric field that can be detected with the appropriate equipment. In the electric mode, the TFM3C's displays will wander away from zero even though there isn't a clear reason for it (not scientifically explainable, aka paranormal!). This would mean something has begun to give off an electric field. What it was in the Ghost Whisperer was a friendly ghost. What it will be in your house... who knows! Makes a GREAT leaning project besides! Requires 4 AA batteries.

TFM3C Tri-Field Meter Kit With Case

\$74.95

Automatic Animated Ghost

- ✓ Automatically greets your visitors!
- ✓ Responds to sudden noises!
- ✓ Built-in microphone!
- ✓ Adjustable sensitivity

Who says ghosts are make believe? Once your friends come upon this one they'll think differently! The unique circuit board design includes two ominous blinking eyes that change with various conditions, including sudden changes in ambient noise. A highly sensitive built-in microphone picks up anything from noises to talking and makes the ghost dance with its built-in motor, make eerie sounds with the built-in speaker, and randomly blink. A white cloth and a hanger are included as shown to make it look like the real thing. Runs on 2 AAA batteries (Not included).



MK166 Automatic Animated Ghost Kit

\$21.95

Halloween Pumpkin

- ✓ 25 bright LED's!
- ✓ Random flash simulates flickering candle!
- ✓ Super bright LED illuminates entire pumpkin!
- ✓ Simple & safe 9V battery operation

The perfect "starter" kit with a terrific Halloween theme! You won't be scraping the seeds and guts out of this pumpkin! Six transistor circuit provides a neat random flash pattern that looks just like a flickering candle. Then a super bright LED illuminates the entire pumpkin with a spooky glow!



The pumpkin face is the actual PC board, and assembly is easy through-hole soldering of all components and LED's. Your pumpkin is powered by a standard 9V battery (not included) which snaps to the back of the pumpkin. An on/off switch is also included. Create a new kind of pumpkin this year, and learn about LED's and electronics at the same time!

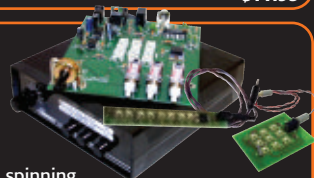
MK145 Electronic Halloween Pumpkin Kit

\$11.95

High Power LED Strobe Light

- ✓ Everlasting LEDs won't burn out!
- ✓ Variable flash rate and audio trigger!
- ✓ Bass and treble trigger modes
- ✓ Safe low voltage construction, no fragile high voltage Xenon tube to break!

Everyone has seen Xenon stroboscopes "stop" a spinning quarter or flash to music. Now you can get the same effect without the expense and hassle of high voltage Xenon tubes! Great for Halloween displays and parties!

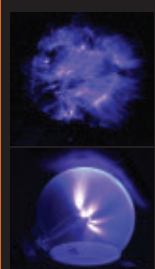


A plug-in 3x3 array of super bright Telux™ LEDs creates a brilliant, sharp flash similar to a Xenon flash tube. The LEDs can also be mounted directly on the main PC board or on a remote display board. Optional display boards also available. Variable flash rate from 1-220 FPS plus an audio flash trigger with selectable bass or treble triggering. Easy to connect with standard stereo RCA audio connectors. External trigger can be looped to additional units for simultaneous flash displays from the same source! Runs on safe 12-15VDC so a great kit for the kids to build!

LEDS1C High Power LED Strobe Light Kit with Case \$49.95
LEDS8 Display Board, Inline Array of 8 LEDs \$17.95
LEDS20 Display Board, 5x4 Array of 20 LEDs \$29.95
AC121 12VDC 1A Regulated Power Supply \$9.95

Spark Generating HV Plasma Generator

- ✓ Generate 2" sparks to a handheld screwdriver!
- ✓ Light fluorescent tubes without wires!
- ✓ Build your own Plasma Balls!
- ✓ Generates up to 25kV @ 20 kHz from a solid state circuit!



This popular kit was conceived by one of our engineers who likes to play with things that can generate large, loud sparks, and other frightening devices! And at Halloween there's no better effect than high voltage sparks flying through the air! The PG13 Plasma Generator creates a very impressive 25,000 volts at 20 kHz, to provide a stunning display of high voltage! It will draw a cool looking 2" spark to a hand held screwdriver, or light fluorescent tubes without any connection!

It produces stunning lighting displays, drawing big sparks, to perform lots of high voltage experiments. In the picture, we took a regular clear "Decora" style light bulb and connected it to the PG13- WOW! A storm of sparks, light tracers and plasma filled the bulb. Holding your hand on the bulb doesn't hurt a bit and you can control the discharge! It can also be used for powering other experiments; let your imagination be your guide! Operates on 16VAC/VDC for maximum output. Can also be run from 5-16VAC/VDC to reduce the output voltage.

PG13 Plasma Generator Kit \$64.95
PS21 110VAC Input, 16VAC Output, Power Supply \$22.95

Super-Pro FM Stereo Radio Station Kit

- ✓ PLL synthesized for drift-free operation
- ✓ Built-in mixer - 2 line inputs and one microphone input, line level monitor output!
- ✓ Frequency range 88.0 to 108.0, 100 kHz steps
- ✓ Precision active low-pass "brick wall" audio filter!
- ✓ Dual LED bar graph audio level meters!
- ✓ Automatic adjustable microphone ducking!
- ✓ Easy to build through-hole design!

FALL FM SALE!



The true professional workhorse of our FM Stereo transmitter line, the FM100B has become the transmitter of choice for both amateurs and professionals around the world. From the serious hobbyist to churches, drive-in theaters, colleges and schools, it continues to be the leader. Not just a transmitter, the FM100B is a fully functional radio station and provides everything but the audio input and antenna system! Just add that and you're on the air!

This professional synthesized transmitter is adjustable directly from the front panel with a large LED digital read-out of the operating frequency. Just enter the setup mode and set your frequency. Once selected and locked you are assured of a rock stable carrier with zero drift. The power output is continuously adjustable throughout the power range of the model selected. In addition, a new layer of anti-static protection for the final RF amplifier stage and audio inputs has been added to protect you from sudden static and power surges.

Audio quality is equally impressive. A precision active low-pass brick wall audio filter and peak level limiters give your signal maximum "punch" while preventing overmodulation. Two sets of rear panel stereo line level inputs are provided with front panel level control for both. Standard unbalanced "RCA" line inputs are used to make it simple to connect to the audio output of your computer, MP3 player, DVD player, cassette deck or any other consumer audio source. Get even more creative and use our K8094 below for digital storage and playback of short announcements and ID's! In addition to the line level inputs, there is a separate front panel microphone input.



All three inputs have independent level controls eliminating the need for a separate audio mixer! Just pot-up the source control when ready, and cross fade to the 2nd line input or mic! It's that simple! In addition to the dual stereo line inputs, a stereo monitor output is provided. This is perfect to drive studio monitors or local in-house PA systems.

The FM100B series includes an attractive metal case, whip antenna and built in 110/220VAC power supply. A BNC connector is also provided for an external antenna. Check out our Tru-Match FM antenna kit, for the perfect mate to the FM100B transmitter.

We also offer a high power kit as well as an export-only assembled version that provides a variable RF output power up to 1 watt. The 1 watt unit must utilize an external antenna properly matched to the operating frequency to maintain a proper VSWR to protect the transmitter.

(Note: The FM100B and FM100BEX are do-it-yourself learning kits that you assemble. The end user is responsible for complying with all FCC rules & regulations within the US or any regulations of their respective governing body. The FM100BWT is for export use and can only be shipped to locations outside the continental US, valid APO/FPO addresses or valid customs brokers for documentation.)

FM100B Super-Pro FM Stereo Radio Station Kit, 5uW to 25mW Output

FM100BEX Super-Pro FM Stereo Radio Station Kit, 5uW to 1W Output

\$239.95

\$299.95

Digital Controlled FM Stereo Transmitters

- ✓ PLL synthesized for drift free operation
- ✓ Front panel digital control and display of all settings and parameters!
- ✓ Professional metal case for noise-free operation
- ✓ EMI filtering on audio and power inputs
- ✓ Super audio quality, rivals commercial broadcasts
- ✓ Available in domestic kit or factory assembled export versions

FALL FM SALE!



For more than a decade we've been the leader in hobbyist FM radio transmitters. We told our engineers we wanted a new technology transmitter that would provide FM100 series quality without the advanced mixer features. They took it as a challenge and designed not one, but TWO transmitters!

The FM30B is designed using through-hole technology and components and is available only as a do-it-yourself kit with a 25mW output very similar to our FM25 series. Then the engineers redesigned their brand-new design using surface mount technology (SMT) for a very special factory assembled and tested FM35BWT version with 1W output for our export only market!

All settings can be changed without taking the cover off! Enter the setup mode from the front panel and step through the menu to make all of your adjustments. A two line LCD display shows you all the settings! In addition to the LCD display, a front panel LED indicates PLL lock so you know you are transmitting.

Besides frequency selection, front panel control and display gives you 256 steps of audio volume (left and right combined) as well as RF output power. A separate balance setting compensates for left/right differences in audio level. In addition to settings, the LCD display shows you "Quality of Signal" to help you set your levels for optimum sound quality. And of course, all settings are stored in non-volatile memory for future use! Both the FM30B and FM35BWT operate on 13.8 to 16VDC and include a 15VDC plug-in power supply. The stylish black metal case measures 5.55"W x 6.45"D x 1.5"H. (Note: After assembly of this do-it-yourself hobby kit, the user is responsible for complying with all FCC rules & regulations within the US, or any regulations of their respective governing body. FM35BWT is for export use and can only be shipped to locations outside the continental US or valid APO/FPO addresses or valid customs brokers for end delivery outside the continental US.)

FM30B Digital FM Stereo Transmitter Kit, 0-25mW, Black

FM35BWT Digital FM Stereo Transmitter, Assembled, 0-1W, Black (Export ONLY)

\$169.95

\$259.95



Synthesized FM Stereo Transmitter Kit

The FM25 has been the hobbyist's standard for FM synthesized stereo transmitters for more than two decades! Just plug in the stereo left/right audio from your MP3 player, CD player, or computer, and broadcast it on any frequency in the standard FM broadcast band.



The sound quality and stereo separation of this little transmitter will keep the pickiest audiophile happy. The FM25B features a PIC microprocessor for easy frequency programming through board mounted DIP switches.

The transmit frequency is PLL controlled for unparalleled stability making frequency drift a thing of the past. The RF output level is adjustable from 5uW to 25 mW. Includes power supply & stereo cable.

(Note: The FM25B is a do-it-yourself learning kit that you assemble. Please remember that the end user is responsible for complying with all FCC rules & regulations within the US, or any regulations of their respective governing body in regards to the application and use of the FM25B.)

FM25B Synth FM Stereo Xmtr Kit

\$119.95

Tunable FM Stereo Transmitter Kit

Here is a great entry-level kit that will teach the basics of FM Broadcast transmission while finding many uses around the home or dorm room. The FM10C has plenty of power to cover your home, backyard, or city block and tunes through the entire 88-108MHz band in three separate ranges with a tuned LC circuit.



Re-broadcast your favorite music commercial-free with the dynamic range the musician intended, and without all that nasty compression the big boys use to make their station sound louder than the competition. Runs on a standard 9V battery or an optional 110 VAC adapter. (Note: The FM10C is a do-it-yourself learning kit that you assemble. Please remember that the end user is responsible for complying with all FCC rules & regulations within the US, or any regulations of their respective governing body in regards to the application and use of the FM10C.)

FM10C FM Stereo Transmitter Kit

\$39.95

Audio Recorder/Player

Record and playback up to 8 minutes of messages from this little board! Built-in condenser mic plus line input, line & speaker outputs. Adjustable sample rate for recording quality. 4-switch operation that can be remote controlled! Runs on 9-12VDC at 500mA.



K8094 Audio Recorder/Player Kit

\$32.95

FM Low Pass Filter

Customers have complained about "dirty" imported FM broadcasters and exciters, so we developed this low pass filter based on our PX50 broadcast xmtr. Really cleans up your output, and connects easily between your transmitter & antenna. Maximum input power is 50 watts.

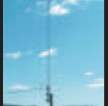


FMLP1 FM Low Pass Filter Kit

\$25.95

Collinear Vertical FM Antenna

Our 5/8 wave omni antenna has been the standard for LPFM installations worldwide. Provides 3.4dB gain while keeping the signal radiation low to the horizon for maximum range. Field tuneable over the entire FM range for a perfect match. SO239 connector.



FMA200E Omnidirectional FM Antenna

\$119.95

Tru-Match FM Antenna

The unique PVC waterproof design has made the TM100 one of the most reliable antennas available for the private broadcaster! Broadband over the entire 88-108MHz range makes installation a breeze without any tuning. Easy "F" connector termination.



TM100 TruMatch FM Broadcast Antenna

\$59.95

GET THE INUTS & VOLTS DISCOUNT!

Mention or enter the coupon code **NVRMZ142** and receive

10% off your order!

Prices, availability, and specifications are subject to change. Not responsible for typos, stupid, printer's bleed, or really weird Halloween tricks! Visit www.ramseykits.com for the latest pricing, specials, terms and conditions. Robin made last month the Halloween edition, but this is October, so I split the difference this month along with FM specials! This is way too complicated! Copyright 2014 Ramsey Electronics®...so there!

800-446-2295
www.ramseykits.com

RAMSEY ELECTRONICS®

590 Fishers Station Drive

Victor, NY 14564

(800) 446-2295

(585) 924-4560

WHAT'S HOT

Test & Measurement and Other Essentials!

OSCILLOSCOPES



Rigol

RIGOL's test & measurement instruments compete with industry leaders – but more affordably: Analog & Mixed-signal Scopes to 1GHz with AWG, Function/AWGs from 20MHz-350MHz RF Signal Gens to 6GHz, Pwr Supplies, DMMs, & Spectrum Analyzers.



Owon

OWON's affordable, reliable, easy-to-use precision benchtop & handheld scopes are unbeatable in their price range. Battery powered and portable options for field use. Owon's Triple Output Power Supplies offer remote control & preset configurations.



Pico

PICO TECHNOLOGY - the world's best PC-based oscilloscopes & data acquisition equipment with the performance of good bench scopes; compact & lightweight - ideal for field work. Award-winning automotive scopes find engine & electric faults quickly.

MISC.

USB Control

Need to interface a PC USB port to other equipment? We have modules for USB-I2C with additional I/O, USB data acquisition, USB-serial (some within the connector itself!), the best and most reliable USB-serial cables, and USB isolators to eliminate ground loops.



Power Supplies

We stock numerous power supplies from simple "wall-warts" for low-voltage/low-current needs, to more complex bench-top supplies with single or multiple outputs, programmable supplies, flexible output current/voltage supplies with multiple communication options.



3D Printers

3D printing makes product and device development faster and cheaper – rapidly build concept parts and projects. We have the latest 3D printers from industry leaders MakerBot and Afinia, as well as the best 3D printing filament available for creating high quality parts quickly!

CIRCUIT/PCB TEST



ABI Electronics

ABI ELECTRONICS - PCB test/repair: BoardMaster 8000: easy-use PCB test system; JTAGMaster: programs/tests via JTAG port; RevEng Schematic Learning System: generates schematics from PCBs; SENTRY: detects counterfeit components.



MQP

MQP ELECTRONICS – USB2.0 Analyzers /Gens, Protocol/Electrical Test equipment, offering unbeatable value/performance ratio and Vbus monitoring. GraphicUSB software offers full analysis of std USB2.0 protocol with Class Analysis options.

Cosview

COSVIEW - range of extremely affordable USB-connected inspection microscopes & stands, very useful for examining printed circuit boards and small integrated circuits for production faults or part number markings. Polarizing filter option which excludes surface glare is available.



Incredible Low Prices, Excellent Customer Service, Free Technical Support

585-385-1750

www.saelig.com

sales@saelig.com

Sign up for our newsletters with 40% off deals!